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George C. Karop.

Joseph Toynbee
from the Author —

ILLUSTRATIONS

OF THE

COMPARATIVE ANATOMY

OF THE

NERVOUS SYSTEM.

BY

JOSEPH SWAN.

LONDON:
LONGMAN, REES, ORME, BROWN, GREEN, AND LONGMAN.
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PREFACE.

The Author having had frequent occasions for referring to Comparative Anatomy during the progress of his publications on the Nervous System, he conceived that representations of his dissections might interest many, and especially assist those who were about to enter upon similar pursuits. But, on so comprehensive a subject, it became difficult to determine upon an arrangement that would make a work concise and useful. After much consideration, it appeared probable that this intention would be in a great measure answered by selecting such examples as would explain the scheme on which the nervous system is generally founded; for thus its practical investigation would be facilitated, and the extension of knowledge promoted in the best and most efficient manner.

It is desirable that researches by actual dissection should be encouraged as much as possible, as thus only can the prospective advantages of science be consulted. If books be entirely confided in, all improvement must stop. These ought, therefore, to be esteemed as mere helps towards that perfection, which can only be approached by the active perseverance of individuals through progressive ages. If the laborious investigations, hitherto instituted, have produced incongruous opinions in physiology, let not their value be underrated, for it may reasonably be presumed, that the modifications of arrangement, which remain undiscovered, will harmonise the whole, and demonstrate the simplicity of unerring truth in this portion of the manifold and wonderful designs of the Creator.

6, TAVISTOCK SQUARE.
October, 1835.

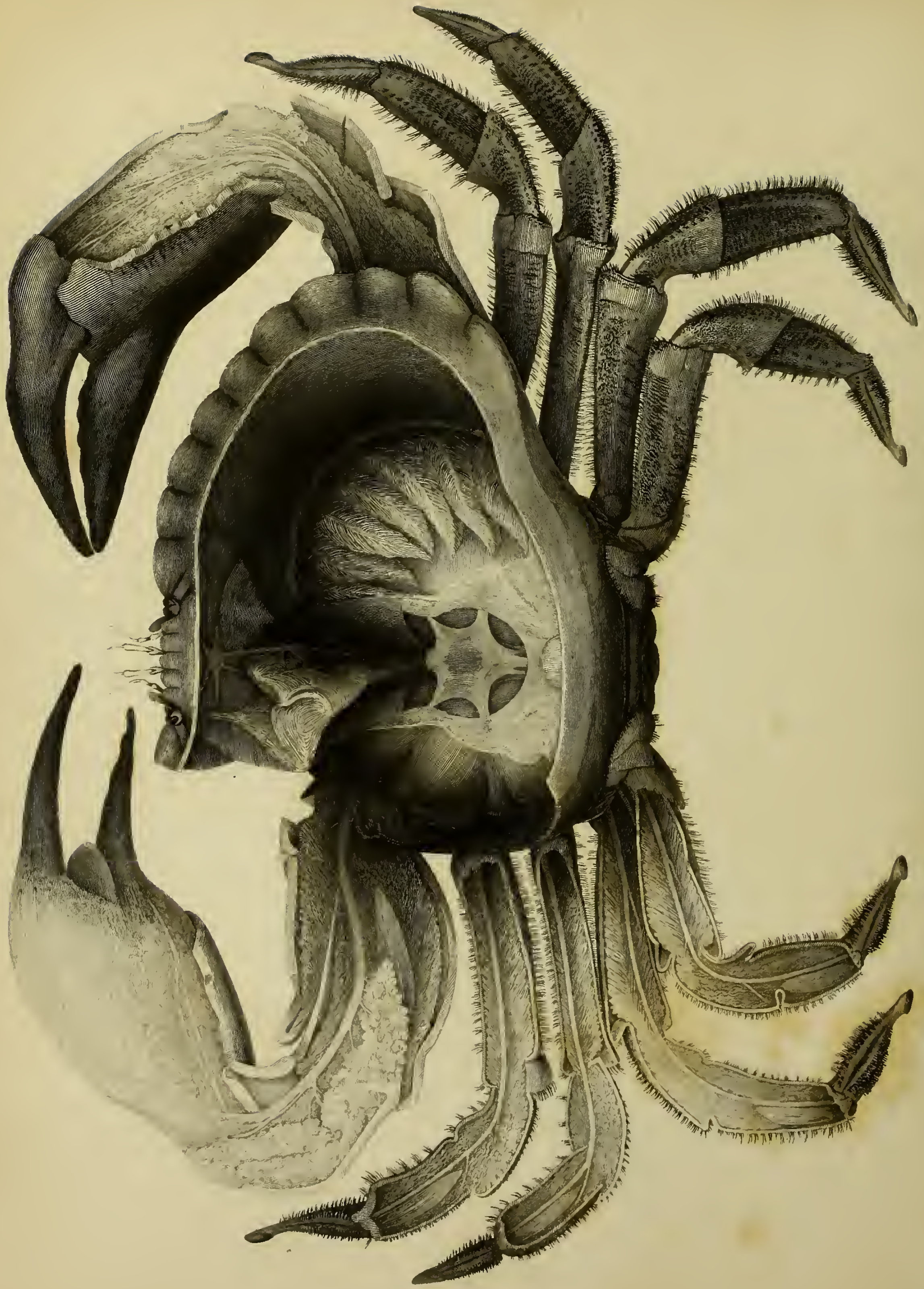

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PLATE I.

DORSAL ASPECT OF THE CRAB.

(CANCER PAGURUS.)

THE brain is seen giving off the nerves to the eyes and contiguous parts, and sending a long nerve on each side of the œsophagus, to supply filaments to the stomach and branchiæ, and pass backwards to join the nervous ring. The continuation of the nerves given off by the nervous ring to the legs is also exhibited. The nervous system in the fresh animal is very transparent, and cannot, without some difficulty, be distinguished from the muscles. It is very soft, and therefore requires a cautious dissection. Much advantage will be gained by the removal of portions of the shell from different parts, and as much as possible of the liver, ovaries, &c.; it should then be immersed in water and gently agitated, so as to wash away the loosened particles, and afterwards placed in spirits of wine for a few days before any attempt is made to trace the nerves.

PLATE II.

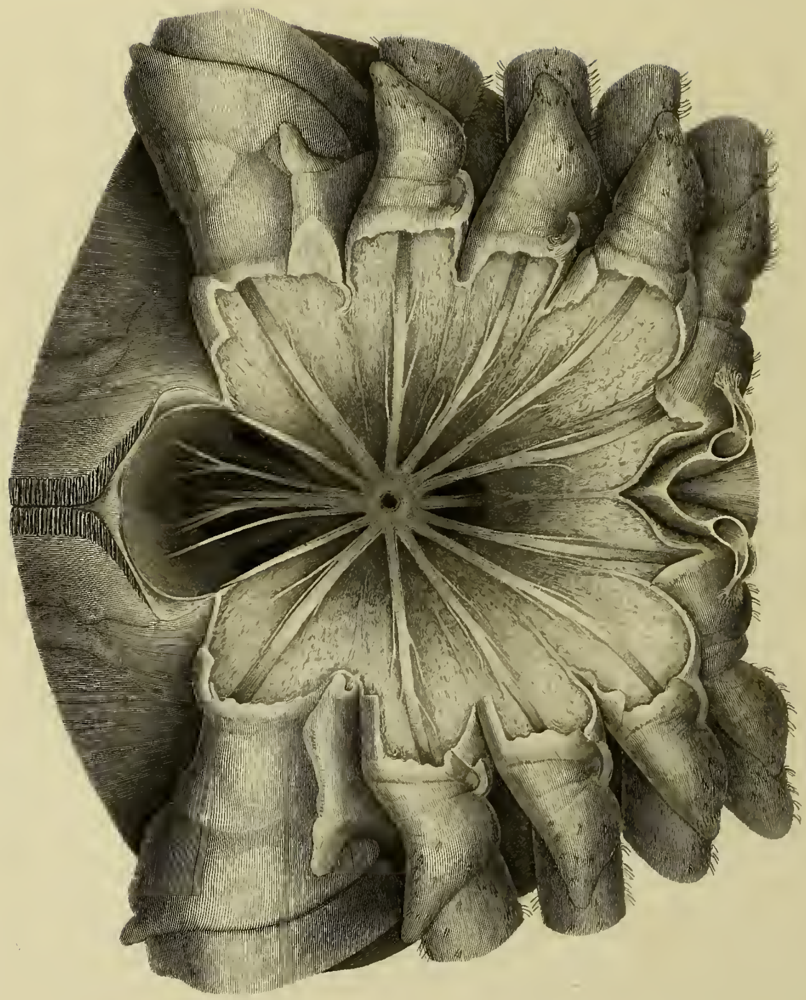

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PLATE II.

VENTRAL ASPECT OF THE CRAB.

(CANCER PAGURUS.)

THE nervous ring is seen sending branches forward to the parts about the mouth, and to be joined by those passing on each side of the œsophagus from the brain; other branches are seen passing to the muscles of the thorax, to the legs, and the muscles of the tail. The tail is formed of many pieces, somewhat resembling the backs of the rings of the lobster, and in each of them slips of muscle are inserted for drawing it towards the thorax; the nerve divides into many branches, which terminate in the muscles, but there is not any appearance of ganglia, as in the tail of the lobster, scorpion, &c.

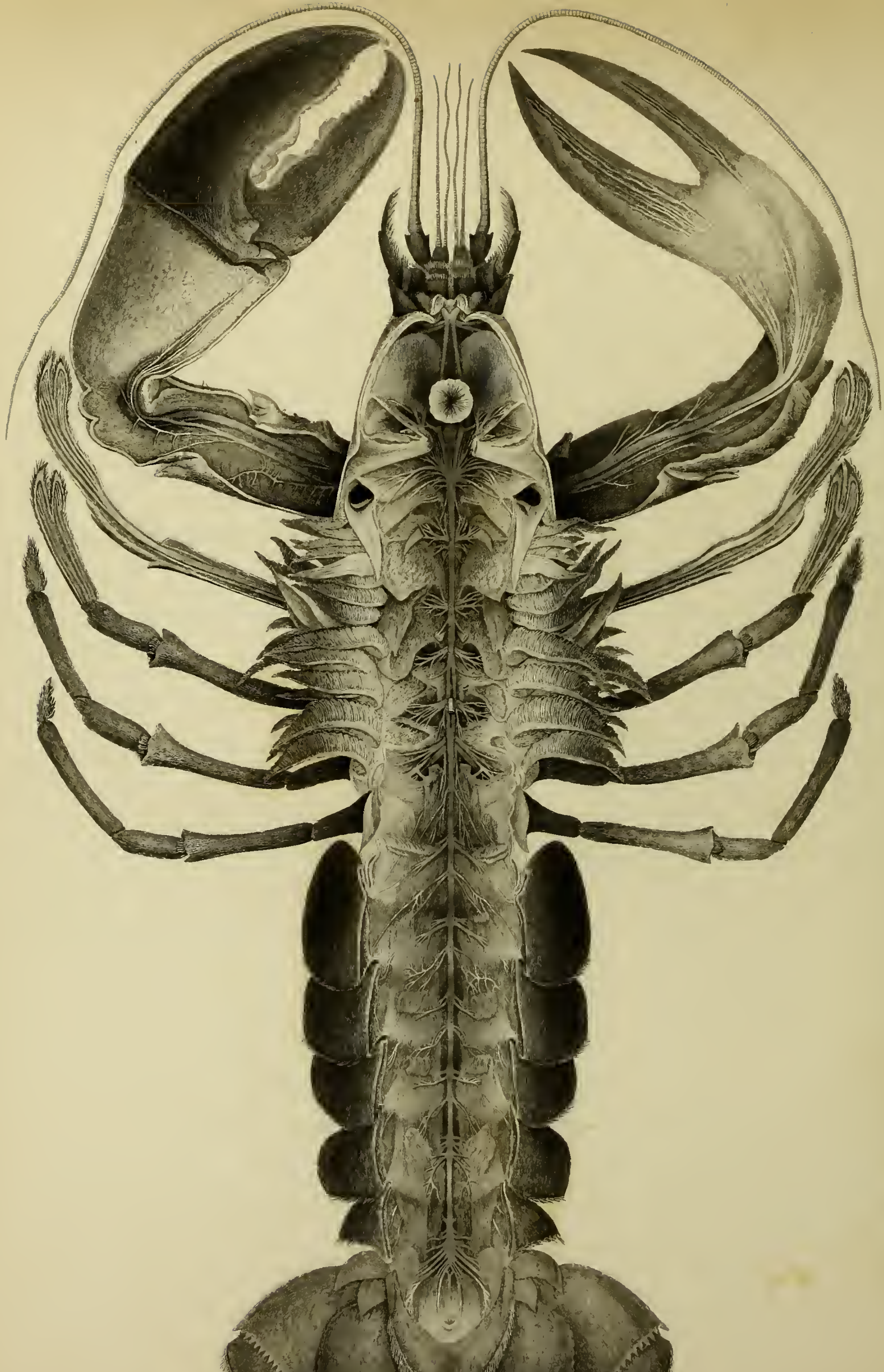

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PLATE III.

DORSAL ASPECT OF THE LOBSTER.

(ASTACUS MARINUS.)

THE brain is seen giving off the optic nerves, and others to the contiguous parts and the feelers, and sending a long nerve on each side of the œsophagus, which gives filaments to the stomach and joins its fellow at the first ganglion: the nervous chord is then continued from this ganglion to the next, and so on to the tail. The chord exhibits more distinct and continued parallel lines on the dorsal surface than on the ventral. The large artery, supplying the extremities, &c., is seen passing between the two halves of the chord, just above the ganglion giving off the nerves to the last pair of legs. Nerves are seen issuing from the ganglia and the chord, to be distributed to the contiguous parts. In this plate the origins of the nerves of the legs are obscured by others passing over them; but their continuations to the tips of the claws are seen. The distinction of the origins of nerves from the dorsal or ventral surface is by no means clear, and cannot be compared with that in most of the vertebrated animals.

In many of the invertebrated animals the dissection may be generally made as for the preparation from which this plate was taken. The dorsal portion of the parietes may be removed, except a small part at the back of the head, which must be carefully cut away afterwards. For a hard shell, a pair of strong cutting forceps must be used; and, for others, common scissors. The brain is placed in the dorsal portion of the head, just above the œsophagus; and some care is necessary in tracing the nerves passing from it on each side of this canal to the first ganglion. The œsophagus is frequently very small, and easily divided; and may sometimes be best observed by introducing a bristle from the mouth. The nervous chord and ganglia will be found in the middle of the ventral parietes, after the superincumbent parts have been carefully separated.

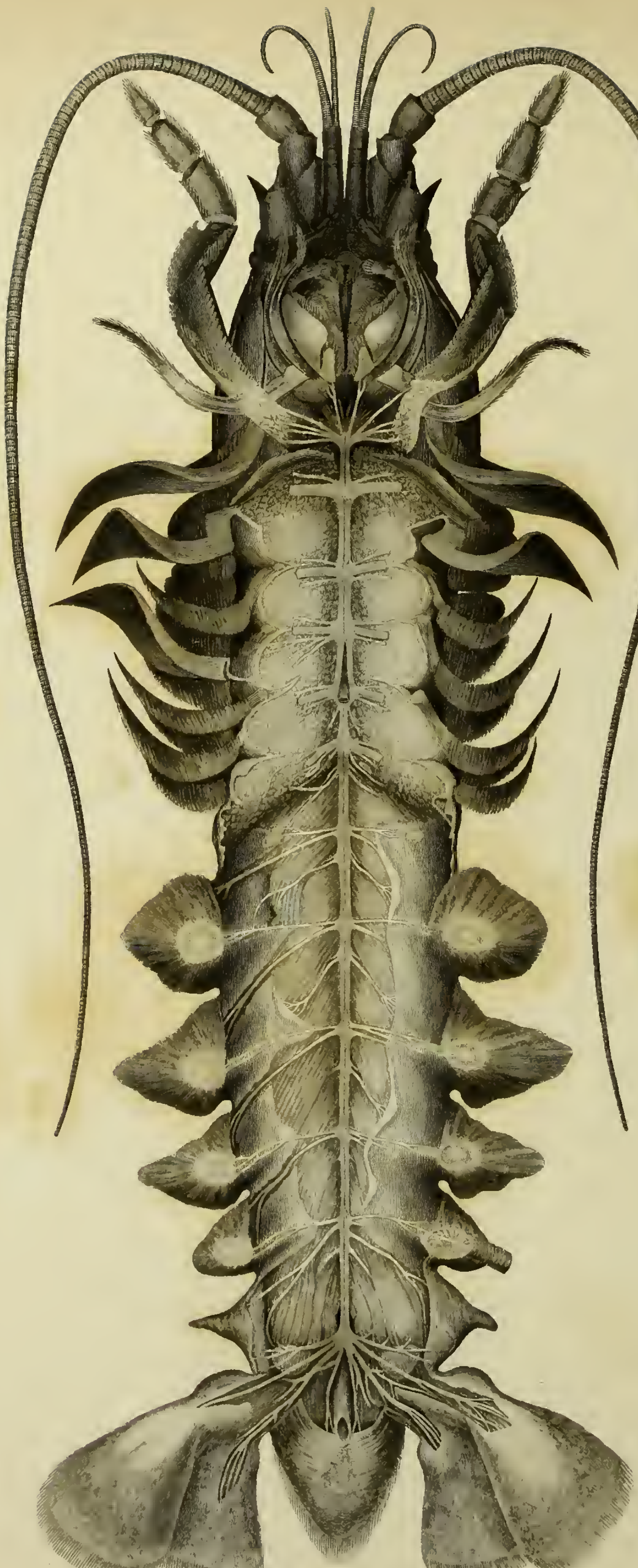

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PLATE IV.

VENTRAL ASPECT OF THE LOBSTER.

(ASTACUS MARINUS.)

THE greatest portion of the shell has been removed from the preparation from which this plate is taken. The nervous chord is seen about the first ganglion after the junction of the nerves passing on each side of the œsophagus from the brain. Branches are seen passing towards the mouth, and to the contiguous parts throughout the course of the chord; the nerves to be given to the legs are seen issuing from the ventral surface of the chord.

The posterior or dorsal layers of the nervous chord do not appear to send distinct fibrils to join the nerves issuing from the anterior or ventral; and the anterior do not send off branches forming distinct and separate ganglia, in the same manner as the posterior origins in most of the vertebrated animals; but the gangliform enlargements are concentrated in the chord.

Fig. 2.

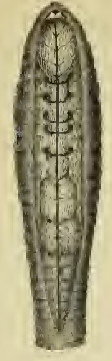

Fig. 3.

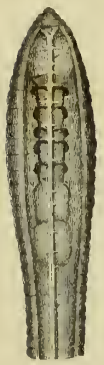

Fig. 4.

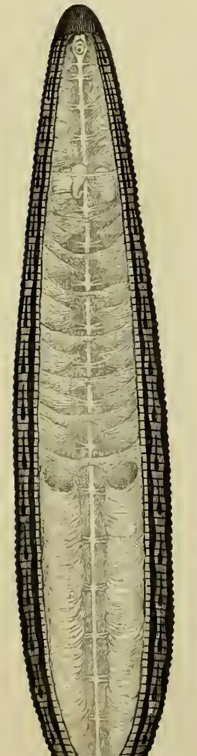

Fig. 1.

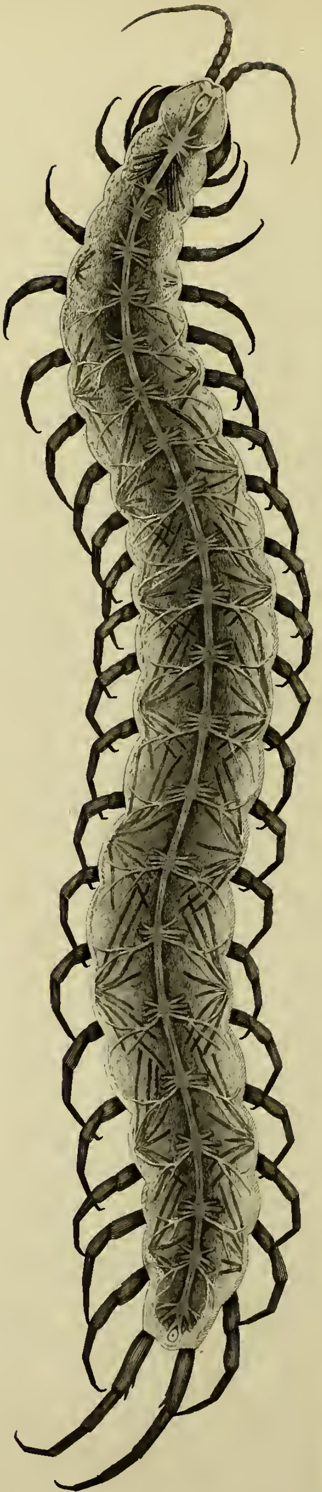

Fig. 5.

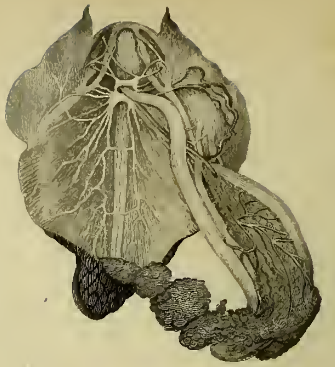

Fig. 6.

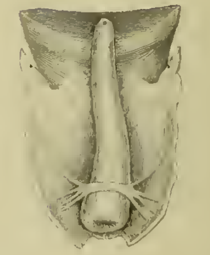

Fig 7.

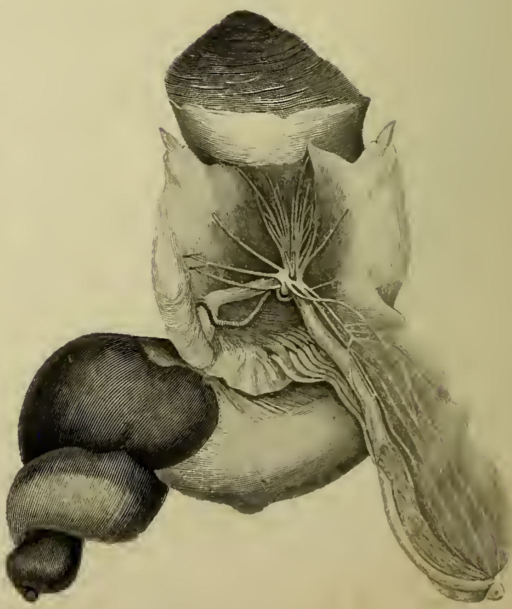

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PLATE V.

FIGURE I.

THE CENTIPEDE.

(SCOLOPENDRA MORSITANS.)

THIS figure shows the brain, and the nerves passing from it on each side of the œsophagus to the first ganglion. It shows the nervous chord, with its numerous ganglia continued to the tail, and giving off branches in a similar manner throughout its course.

FIGURE II.

DORSAL ASPECT OF THE EARTH WORM.

(LUMBRICUS TERRESTRIS.)

After removing the dorsal parietes the brain is seen, and the membranous sacs, or hearts, communicating with the dorsal bloodvessel.

FIGURE III.

VENTRAL ASPECT OF THE EARTH WORM.

(LUMBRICUS TERRESTRIS.)

After removing the ventral parietes the nerves are seen passing on each side of the œsophagus from the brain to the nervous chord. A bloodvessel is seen passing on the nervous chord throughout its whole length ; the large ventral bloodvessel is seen, and its communications with the membranous sacs, or hearts.

FIGURE IV.

THE LEECH.

(HIRUDO MEDICINALIS.)

This figure shows the brain of the leech placed above the œsophagus, and the nerve passing from it on each side of this canal to the first ganglion ; the nervous chord is seen extending throughout the length of the body on the ventral parietes, and its several ganglia sending off nerves to the contiguous parts.

FIGURE V.

THE SLUG.

(LIMAX ATER.)

The slug was opened on the dorsal surface ; the brain is seen placed above or on the dorsal portion of the œsophagus, and giving filaments to the feelers, and the parts about the mouth ; a ganglion is seen larger than the brain, placed beneath or next the ventral surface of the œsophagus, and connected by a narrow band with the brain. The nerves are seen proceeding from the ganglion principally to the fleshy foot and integuments, and giving some small branches to the heart and digestive organs.

FIGURE VI.

THE WHELK.

(BUCCINUM UNDATUM.)

After dividing the surface from the edge of the broad end of the foot towards the parts contained in the apex of the shell, a pink substance resembling a ganglion is seen on the proboscis; it is connected by filaments on each side to the contiguous parts and the nervous ring.

FIGURE VII.

THE WHELK.

(BUCCINUM UNDATUM.)

This figure shows the principal part of the nervous system in a ring divided into two parts, and encircling a bloodvessel and the alimentary canal. The proboscis has been turned aside for allowing some of the nerves to be seen terminating on this part, and others on the fleshy foot.

The nervous system requires to be so adapted to the skeleton, that a sudden shock cannot easily be communicated to it, otherwise its functions would be liable to be momentarily and permanently annihilated. A peculiar conformation is also necessary for preventing a compression or overstretching of such parts of it as are subjected to motion; in the spinal marrow this is answered by the small circumference of this organ when the motion of the vertebræ is considerable, and when it is still greater, as in the hedge-hog, by a long cauda equina, the short and thick spinal marrow being placed where very little flexion is allowed. The same precaution is also required respecting the nerves, and is fulfilled by their mode of origin, their proper adaptation to the openings through which they are conducted, and their proportionate size to the parts they are connected with in their passage, as well as to those they supply; without this careful arrangement, the motions of the bones and muscles might interfere with their functions, they might be too bulky for easy flexion and extension, or too slender for a connection with structures possessing considerable power and motion.

When the lengthened appendage to the brain, the spinal marrow, ceased to be necessary, analogy would have pointed out as a substitute for it one or more nerves arising from a brain or ganglion, and giving off branches in its course to the contiguous parts. But it would have been difficult even to have conducted safely a simple chord along the moveable rings of some invertebrated animals. If parts of much extent were to be furnished, it must have proceeded from a large brain or ganglion; it must have been of considerable thickness, and therefore ill-accommodated to the surrounding structures; but it could not then have been even contained in the narrowed portions of the body of many insects; or, if it had been flat and extended, so as to have been fitted to the form of a sufficiently spacious external shell or covering, it might have been very inconveniently placed for giving off branches to the powerful muscles. Although one large ganglion is adapted to the oval form of the crab, it would have been very unsuitable to the lengthened body of the lobster, which requires the greatest portion of its nerves to pass in one direction. In the tail of the crab, a nerve of moderate size suffices for the slender muscles; but it would not for the large and powerful ones in that of the lobster. For producing, therefore, a convenient distribution of the nerves in the varying forms of many invertebrated animals, ganglia of different sizes have been adopted and placed at proper distances from each other.

In vertebrated animals the spinal marrow is composed of soft medullary matter; in many of the invertebrated, a fibrous chord, with more or fewer intervening ganglia, is substituted for it. There is, however, this great difference, that the spinal marrow gives off nerves which terminate in ganglia; whilst in the invertebrated these are inserted into the chord itself. As the ganglia must generally be proportioned to the nerves, it is probable that the essence of the nervous system exists in them, as it does in the brain and spinal marrow; but, as their composition is very different, so it may be well adapted for the performance of the peculiar functions of creatures so differently constructed.

Whilst each ganglion is a centre for distributing nerves in convenient quantities, to suit the situation and structure of the various parts of invertebrated animals, it can act with or through others almost in the same manner as if it had formed a portion of a simple nerve, or of a number of ganglia concentrated as in the crab. It is probable that some parts of ganglia are different in composition from others, and not so susceptible of excitement as the nerves, therefore a firmer attachment to the contiguous structures is allowed by them without the production of pain or other inconvenience. Besides those giving off the nerves generally, others exist for forming fresh dispositions of particular branches, so as to harmonise with the peculiarities of the organs of different animals.

In many invertebrated animals no nervous system has been discovered; it may, however, exist; but, from its delicacy or transparency, have eluded the penetration of the human eye. Its most simple form or type is a chord or ring giving filaments to the contiguous parts. In very numerous instances there is a brain or ganglion placed above or on the dorsal portion of the œsophagus, and a nerve longer or shorter passing from it on each side of this canal to a ganglion, situated below or on the ventral parietes; a nervous collar is thus produced, and is sometimes partitioned so as to form a double ring. From the brain and this ganglion the principal nerves are in some instances at once sent off; or there is a chord or prolongation, composed of two portions, more or less separated, and extending from the first ganglion to a second, and so on with respect to the rest. Generally the nerves arise from the ganglia, but sometimes from the prolongation also. The ganglia vary in number, and are larger or smaller in proportion to the quantity of nerves given off by each of them. They are more concentrated when the skeleton is round or oval, when the motion of the part on which they are placed is so constrained that their functions cannot be interfered with, and the extremities can be more conveniently supplied by them with nerves. In the crab there is one large ganglion for furnishing all the legs; and, in the spider, there is a similar disposition; in the lobster, whose skeleton is elongated, and its different parts more moveable, there are several; but those, beyond the one giving nerves to the last pair of legs, are much smaller than the rest. When the rings and legs are nearly the same throughout, as in the centipede, they are of an almost equal size, and as numerous as the divisions of the skeleton; and thus a very free motion is allowed without any disarrangement of the nerves. So many ganglia might, however, have been dispensed with, and a large one have given origin to all the nerves, as the short spinal marrow does in the hedge-hog; but the nerves must then have been confined, as they are in the spinal canal of this animal, and have passed through separate openings,—a conformation that must at least have added very much to the bulk of the skeleton. Creatures like the leech, which are capable of great and sudden changes in the size of the body, derive the highest advantage from numerous ganglia, as these allow either a contraction or distension of the stomach without inconvenience; for, whilst a simple chord in the empty state might have been displaced sufficiently for interfering with the distribution of its branches, in the distended state it might have been overstretched, and the functions of the whole impaired. In the slug, which is less capable of being subjected to similar inconvenience, because the variations of its alimentary canal are more limited, there is one principal ganglion besides the brain, from which the nerves arise. The changes that take place from the state of the larva to that of the perfect insect, demonstrate the necessity for a proper adaptation of the ganglia and nerves to the new form of the body. It would seem that a mass of ganglion, in larger or smaller divisions, proportionate to the requisite quantity of nerves, must be provided, and only placed in an appropriate form for corresponding with the shape as well as the locomotive necessities and other requisite changes of the body.

If there be any resemblance between the structure of the nervous system of many invertebrated animals and that of man, it is very faint; if its disposition in some instances countenance a comparison, that in others does not in the least; and so peculiar is the connection of the nerves with the brain, that it would be useless to attempt to class them in the same manner, either as regards their names or their origins. If the rudiments of any of the organs of the senses exist, these, as well as the nerves supplying them, generally bear the same distant resemblance; but the eye and optic nerve may in some instances form an exception. In the lobster, one of the largest of these creatures, and therefore well fitted for observation, there is so little difference in the nerves supplying the organs of sense and motion, as far as regards their apparent origins from the brain, as to make any distinction almost conjectural. Although the nervous chord is sometimes rather different on its two surfaces, inasmuch as there is a ganglion inserted into the ventral, and a layer of longitudinal fibres passing over the dorsal, yet this distinction does not generally exist. Its resemblance to the spinal marrow, and especially with respect to its giving origin to the nerves, is very distant; for some fibres do not proceed from the ventral surface, and others from the dorsal to be united to form one nerve, but are conveyed separately, and without any intermixture to parts similar in appearance and structure.

The actions of animals, and particularly of many of the invertebrated, do not altogether depend on the brain, but are promoted very much by external circumstances. Thus sentient parts may be impressed, and the powers of the muscles excited through the communications of their respective nerves. Hunger accompanies this change, or the increase of the procreative organs, which have hitherto lain dormant; and thus each necessity produces a fresh stimulus to action. It is, however, difficult to ascertain how great a share the brain itself takes in determining their instinctive faculties, and particularly in the collection and storing of food, their knowledge and subtlety in directing their motions, &c.

The various parts of the nervous system throughout the animal creation are developed with different degrees of comparative perfection. In man, whose faculties are so exalted, it has a decided superiority over that of every animal. The parts of the brain with which the mental powers are interwoven, are not only larger, but the nervous system as a whole is more complicated, and in all its relations more distinct, especially with respect to the sympathetic nerve. Animals may in some particulars appear to have the advantage of man; they have some organs larger; they have, also, larger nerves; and the parts of the brain giving origin to these are proportionately more developed. But if a portion of one of these larger organs be compared with a corresponding extent of the same in man, it will be generally found that there is not any superiority of structure, but only a larger nerve and a larger surface for receiving its distributions.

There are different degrees of development in the brain and spinal marrow of animals; and the medullary matter itself, of which these parts are composed, is more or less soft and translucent, as if the proportion of this to the membrane was diminished; the nerves, also, partake of the same quality, in this respect approaching towards the state of the invertebrated classes. In the sympathetic nerve of various animals there are also different degrees of development; its several parts are either very deficient or more or less conjoined with the cerebral and spinal nerves than in man; it may be partially apparent on, or become confounded with a cerebral nerve, and in the same manner with the spinal nerves or their ganglia.

The different appearance of the nerves encircling the œsophagus, and forming a connection between the brain and first ganglion in invertebrated animals, can sustain only a very slight claim to a comparison with that between the brain and spinal marrow of the vertebrated. If any other be allowable, it is with the par vagum of those animals, in which the sympathetic nerve becomes so combined with the ganglia of the dorsal nerves as not to admit of a separation. These compound ganglia terminate after the usual manner of the dorsal nerves in the muscles and skin, except that some of them send branches to the viscera. If, therefore, the spinal chord were removed, and the ganglia with the prolongations of each side were drawn together, through the connection of the par vagum with the brain, a nervous chord similar to that of many invertebrated animals would be produced. This would be a different combination; but it might be well suited to the lower degree of the animal. It may not be necessary in these creatures for the nerves of sensation and motion to be separate, but it may suffice to have a chord of a mixed character, and capable of conferring both qualities, as in the glosso-pharyngeal nerve in man, the par vagum, and some others. If it be presumed that the connection of the brain and first ganglion cannot be compared with the par vagum, because voluntary muscles are to be actuated and sensation communicated through it, let it be remembered that the par vagum conveys the commands of the will in man to the vocal organs at least, and, in some animals, to those connected with digestion; and that it has also sensiferous qualities; and these properties it is conceived may be as readily transmitted by one or more ganglia to the different parts as by the nerves themselves.

If the nice distinction of the several portions of the nervous system of man be not necessary in animals, which are a very little beneath him as far as respects the greatest number of their organs, it is reasonable to suppose that in creatures much inferior to these the nervous system would be lowered in the same degree. It may be presumed that many invertebrated animals, whose movements are determined as much by external agents as the will, should have their nervous system approaching considerably to that of the sympathetic in the higher classes, as their attributes accord very much with the almost automatic actions and duller sensibility dependent on this nerve. In those, having somewhat higher faculties than the rest, the brain may be more exquisitely formed, but the nervous system, as a whole, may still be inferior to that of creatures possessing a spinal marrow; it may, however, have been altogether so much altered in form and qualified in composition, as to be very different from that in man, but suited to correspond with the organization of each animal.

Much very curious and interesting information has been obtained from the examination of the fœtus during its different stages of uterine existence, and particularly respecting the resemblance of the brain to that of the different classes of animals according to its approach to or its distance from maturity. In the human fœtus, the sympathetic as well as the spinal nerves and their ganglia are formed at an early period, and when very little more is apparent than the membranes of the spinal marrow. This circumstance favours the opinion, that the long chord of invertebrated animals is not the prototype of the spinal marrow, but of the spinal ganglia and their nerves, the sympathetic and par vagum, according to the preceding observations. But, in whatever way the subject be considered, much must be left to conjecture. A very distant resemblance is all that can reasonably be expected to be found in creatures so different in their form and mode of existence.

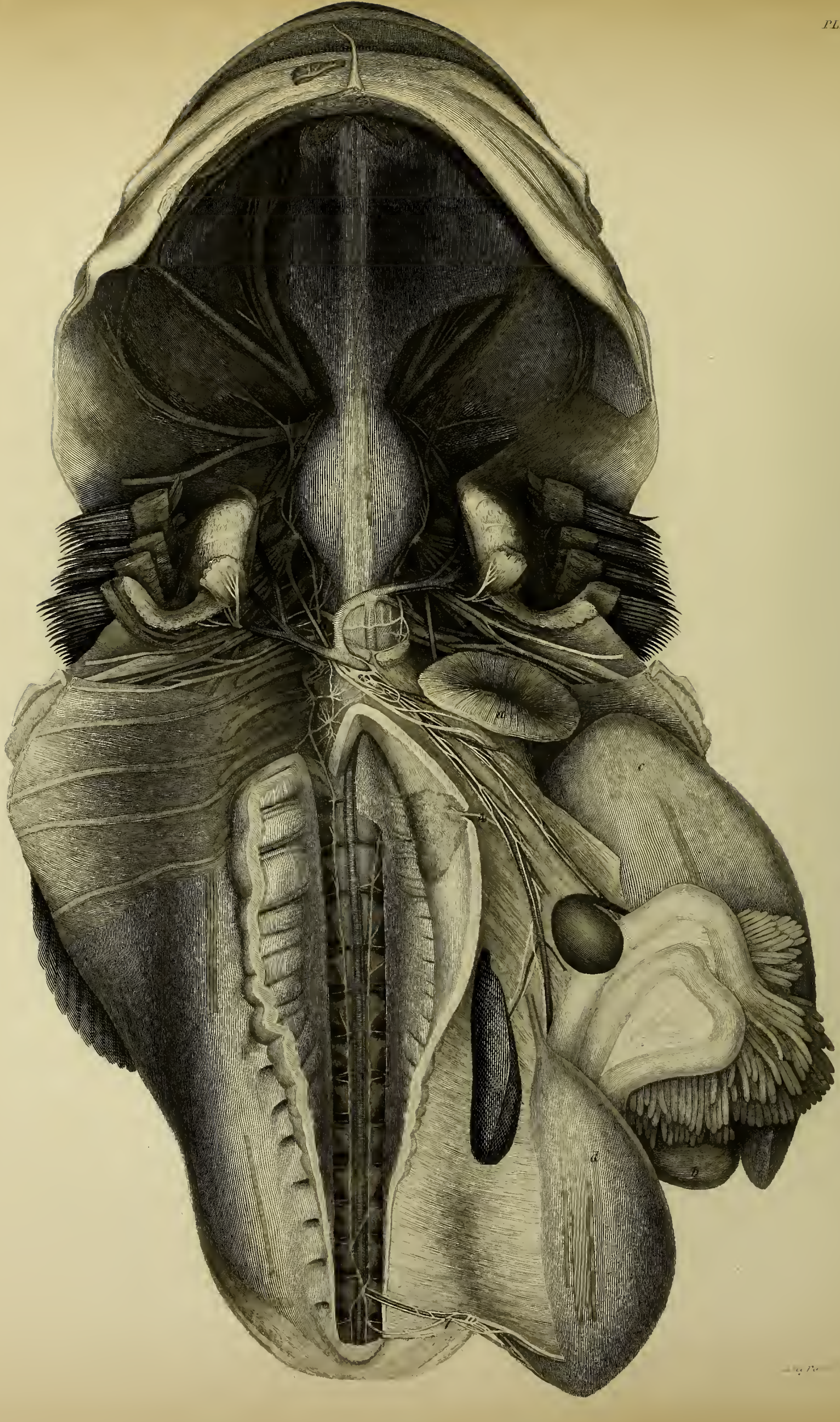

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PLATE VI.

THE SYMPATHETIC NERVE OF THE COD.

(GADUS MORRHUA.)

In the preparation from which this plate has been taken, the parts constituting the thorax, the abdominal muscles and portions of the gills have been removed; the œsophagus has been detached, and the air bag laid open; the blood-vessels are seen passing down from the gills and uniting and sending off the mesenteric artery and forming the aorta to be continued down the middle of the spine.

a, Œsophagus; *b,* stomach; *c,* liver; *d,* right ovary.

1. Large branches of the fifth supplying the muscles and skin of the head and face and membrane of the mouth.

2. A nerve proceeding from one of the bundles about to form a trunk of the par vagum; it communicates with the auditory nerve, and passes to the first partition of the gills, and gives off filaments to the pectinated processes.

3. Right trunk of the par vagum, giving branches to the gills and muscles connected with these parts, sending two outwards and downwards underneath the skin of the side, and a larger one to the stomach.

4. A small branch, given off by the trunk of the par vagum to pierce the air bag and terminate on the parenchymatous structure, similar in appearance to the lungs.

5. Sympathetic nerve. Its origin appears to be first a branch of the fifth; it passes down and becomes connected with the nerve 2, then with the trunk of the par vagum, and afterwards with each of the spinal nerves. On the left side, after sending

a filament to join the trunk of the par vagum on the stomach, it sends a branch across to join its fellow on the right side, in the splanchnic nerve. This forms a ganglionic enlargement on the mesenteric artery; and, after communicating with the right trunk of the par vagum, terminates on the intestines and other viscera. On each side of the aorta the prolongation of the sympathetic is continued down to the tail, giving filaments to the lateral branches proceeding from the aorta, and communicating with the spinal nerves. Near the anus filaments are sent off, which unite and accompany the spermatic artery to the ovaries.

6. Junction of the branches from the sympathetic of each side, to form the splanchnic nerve.

7. Spermatic nerves.

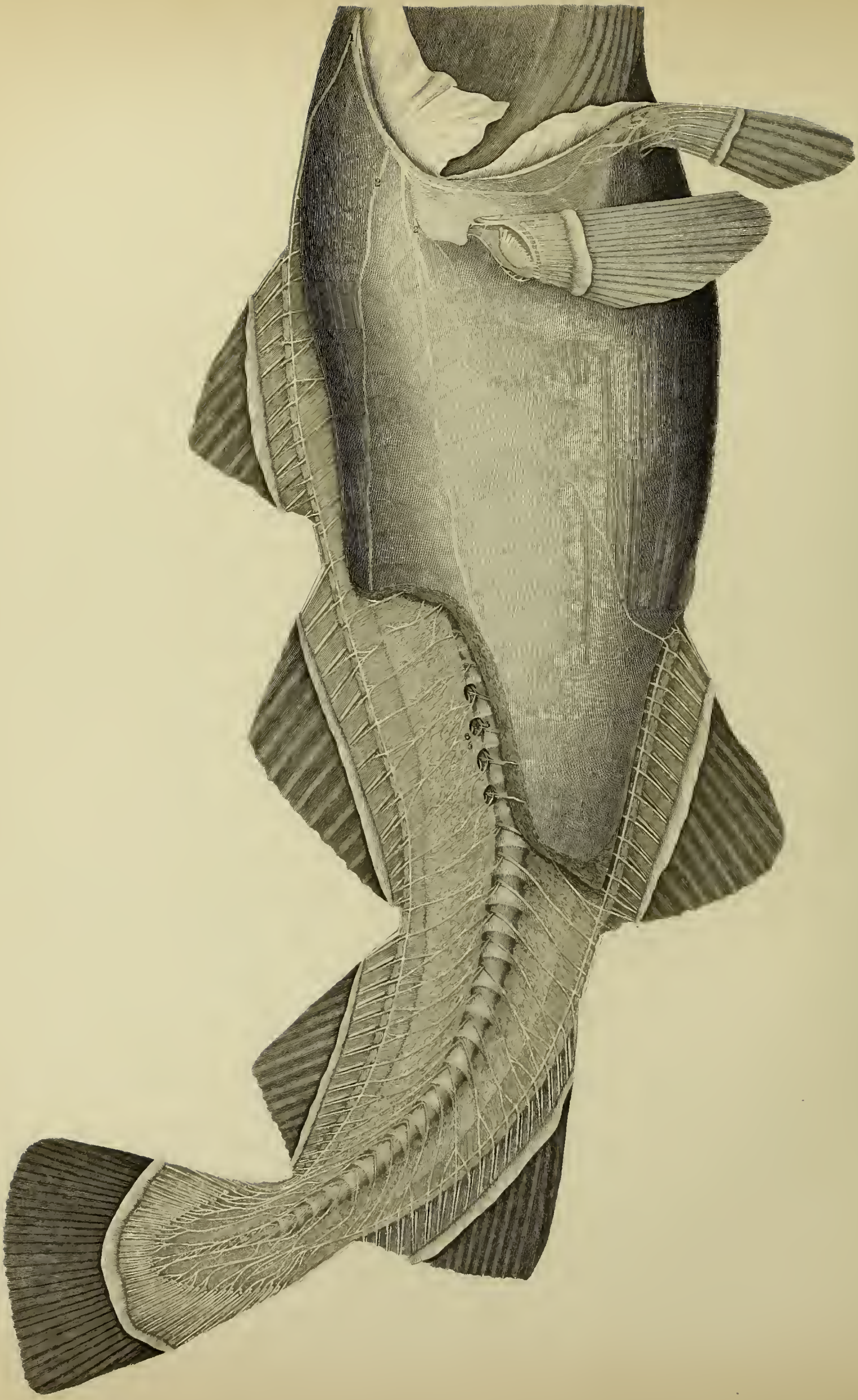

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PLATE VII.

THE SPINAL NERVES OF THE COD.

(GADUS MORRHUA.)

1. A LARGE branch of the fifth, joined by a filament from one of the bundles about to form the par vagum, just as it issues from the posterior part of the head. It divides, and sends a branch downwards, close to the spinous processes, and communicates with all the branches of the spinal nerves passing towards the dorsal fins; another communicates with the nerves supplying the jugular and pectoral fins; a third is directed towards the abdomen, and passes down to the tail, to communicate with the nerves of the ventral fins. Besides these branches, others are given off by it to the skin at the back of the head.

2. Two branches from the trunk of the par vagum, passing downwards on the side underneath the skin; one is directed towards the tail, the other towards the back.

3. Part of the anterior origin of a spinal nerve passing forwards.

4. Part of the posterior origin of a spinal nerve passing forwards.

5. Part of the anterior origin of the same spinal nerve passing backwards.

6. Part of the posterior origin of the same spinal nerve passing backwards.

The disposition of the spinal nerves is very interesting. Each anterior and posterior bundle, issuing from the spinal chord, is divided into two branches. One branch from the anterior bundle is joined by one from the posterior, and passes forward to the muscles and skin on the anterior part of the spine; the other branch of the anterior bundle, after it has communicated with the posterior branch passing forward, passes backward, and is joined by the second branch of the next posterior bundle, to terminate on the muscles and skin on the posterior part of the spine. Neither of the branches of the posterior bundle forms a ganglion.

The same disposition of the spinal nerves is continued to within a short distance from the tail, when the whole of each anterior and posterior bundle becomes joined, and the division into branches for the muscles and skin, on the anterior and posterior parts of the spine, takes place. The spinal marrow terminates in a bulb near the tail.

The great simplicity of combination in the spinal nerves of the cod proves that the anterior bundles are not for exciting one set of muscles, and the posterior their antagonists, as it is clearly demonstrated that one portion of the anterior supplies the muscles on the anterior part of the body, and the other those on the posterior. As ganglia are not attached to the posterior bundles, it is clear that these bodies are not an indispensable adjunct to the nerves of sensation.

After due consideration, it must appear, that besides the power of conveying sensation and motion, the fifth, and particularly its junction with the spinal nerves terminating in the fins, can produce sympathy or harmonious co-operation. Such a connection is not required in fishes, either for the voluntary action of the muscles or the sensibility of the skin, as it exists only in some instances; the hard portion of the seventh in man may, in the same manner, be quite equal to the separate and peculiar functions of the parts on which it is distributed, and only associated with the branches of the fifth for sympathy.

Many actions are promoted by nervous communications or sympathies, so that the active faculties of the brain need not be exercised on every slight occasion. The fifth in the cod, and particularly its posterior branch, is so extensively connected with the nerves of the fins, that the action of the muscles of these parts may not only be regulated by it, but produced without the command of the will.

The skin of the head and fins may be capable of receiving impressions from sound, or any agitation of the surrounding water, and of having them conveyed by this nerve to the labyrinth. The gills may derive the same capability from the connection of the par vagum with the auditory nerve; it may also be presumed that some invertebrated animals can appreciate sounds or motions of the air and water by their respiratory organs or vessels, and others by the skin. This may not be such a sensation as is experienced in vertebrated animals by means of a complicated organ for collecting and measuring sounds to suit the capacity of the brain and the peculiar state of each individual, but it may be an impression of a similar kind, as the most perfect hearing is only a perception of mechanical changes in air or water; and there may be various degrees of this, approaching more or less to common feeling, according to the complexity or simplicity of the parts on which the nerves are distributed. Almost all creatures have some locomotive powers or means of defence, so they must, therefore, have the capability of knowing when to use them, through a sensation communicated by the surrounding elements, and this may be feeling in some and hearing in others.

Fig. 1.

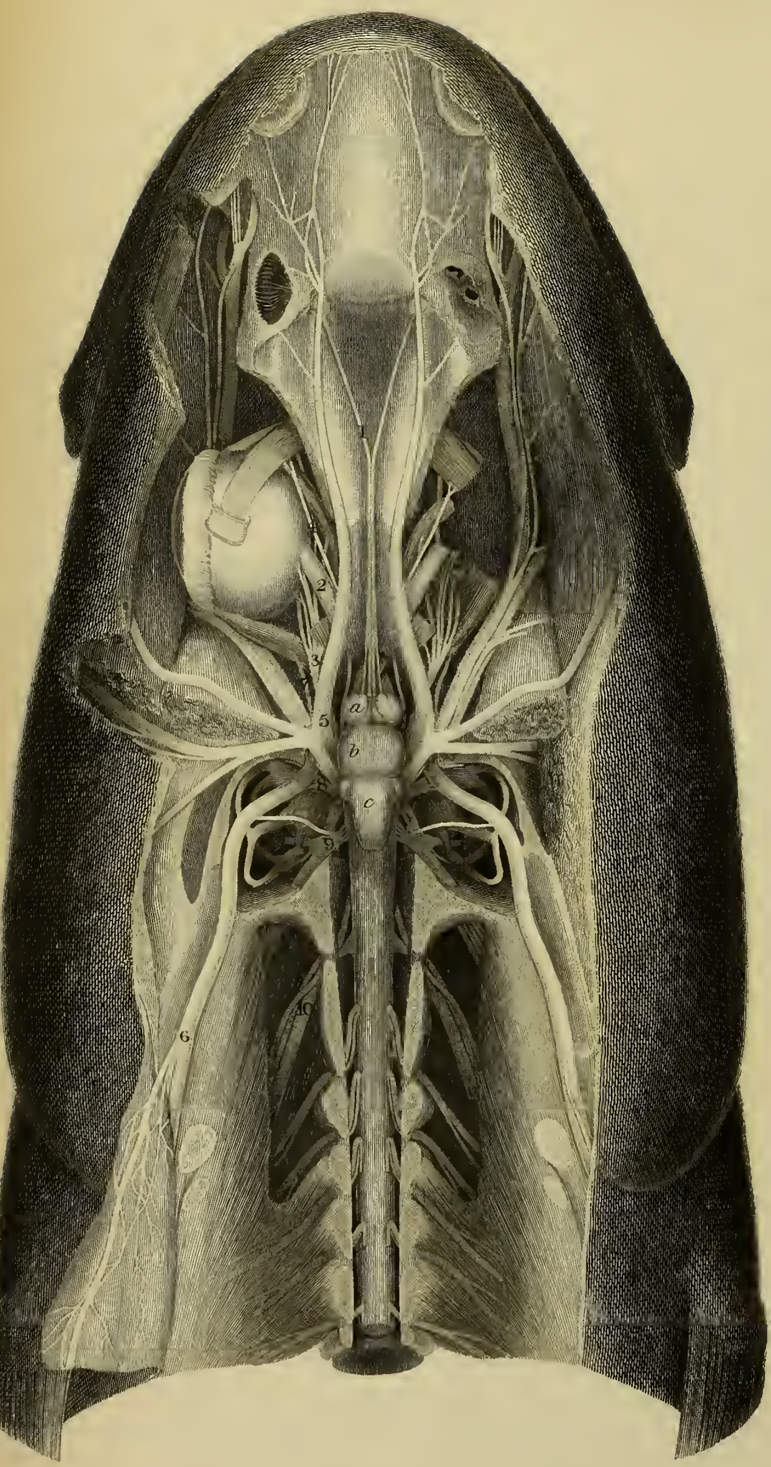


Fig 2.

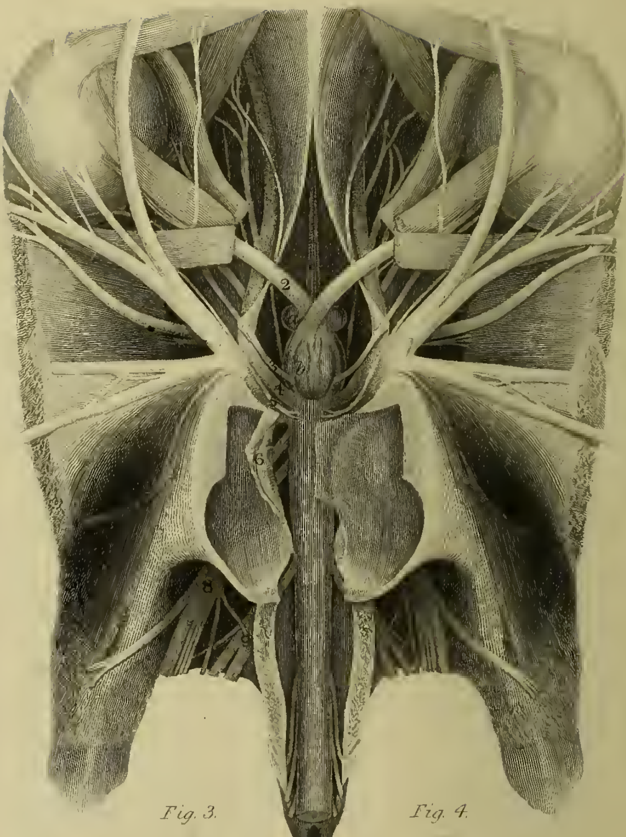


Fig. 3.

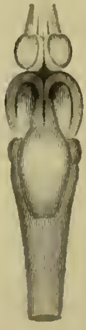
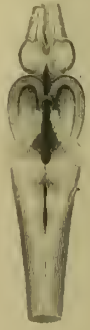


Fig. 4.



[illegible]   Engraved by Finden.

London Published [illegible]

PLATE VIII.

THE COD.

(GADUS MORRHUA.)

FIGURE I.

THE DORSAL ASPECT OF THE BRAIN AND SPINAL CHORD

a. ANTERIOR lobes of the brain.

b. Optic or posterior lobes of the brain.

c. Cerebellum.

1. Olfactory nerve, arising from the anterior lobe of the brain, and passing forward and forming a round ganglion near the nose, from which branches are sent to the membranous plaits or folds exposed on the left side.

2. Optic nerve.

3. Third nerve, giving branches to all the muscles of the eye, except the superior oblique and abductor, and sending ciliary branches to the interior of this organ.

4. Fourth or pathetic nerve, arising just behind the posterior point of the optic lobe.

5. Fifth nerve, arising from the restiform body, and dividing into several large branches, to be distributed on the muscles and skin of the head and face; many of those given to the skin pass in filaments through openings in the bone.

F

6. Posterior branch of the fifth, receiving a filament from one of the bundles about to form the trunk of the par vagum, and being continued to communicate with the nerves of the fins, as in 1., Plate VII.

7. Sixth or abducent nerve.

8. Auditory nerve, arising from the restiform body, near the fifth, and giving branches to the semicircular canals, and the sack containing the stone.

9. Trunk of the par vagum, arising from the restiform body.

10. First spinal nerve.

FIGURE II.

THE BASE OF THE BRAIN, AND THE ORIGINS OF THE NERVES.

a. Anterior lobes of the brain.

b. Mammillary eminences, which are much larger than in the skate; the pituitary gland has been removed.

1. Olfactory nerve.

2. Optic nerve, arising from the optic lobe and the mammillary eminence, and crossing its fellow to terminate in the retina.

3. Third nerve, arising from the base of the brain, in the track of the pyramidal body, a little behind the mammillary eminence.

4. Fifth nerve, arising entirely from the restiform body.

5. Sixth nerve, arising from the base of the brain, in the track of the pyramidal body.

6. Crescentic nerve, expanded on the sack containing the stone; it originates from a branch of the auditory nerve and a filament from one of the bundles about to form the trunk of the par vagum.

7. A branch from the par vagum to the first partition of the gills; it may be compared with the glosso-pharyngeal in the skate.

8. Trunk of the par vagum, arising from the restiform body; this is the last of the cerebral nerves.

9. First spinal nerve.

FIGURE III.

Part of the optic lobe has been removed for exposing the ventricle, which is continued from near the anterior lobes; it passes under a commissure between the optic lobes, and is continued under the cerebellum to the calamus scriptorius; the longitudinal bands or columns on its floor are not so distinct as in the skate. The anterior point of the cerebellum, which was previously concealed, enters into the ventricle of the optic lobes. There is not so distinct a cavity in the cerebellum as in that of the skate.

FIGURE IV.

The greatest part of the cerebellum has been removed from the preparation from which the preceding figure was taken, for showing the continuation of the ventricle to the calamus scriptorius.

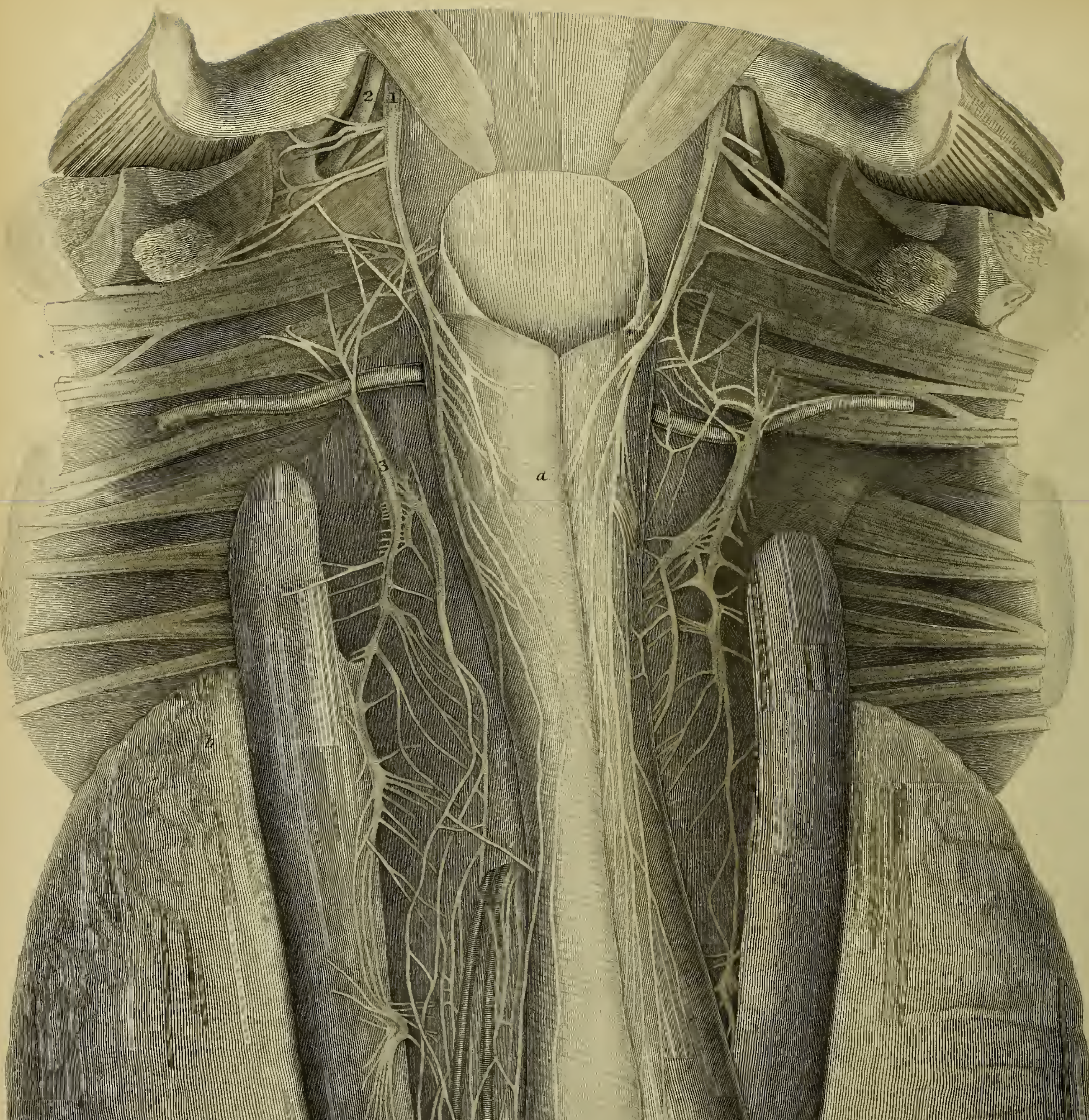


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PLATE IX.

THE SYMPATHETIC NERVE OF THE SKATE.

(RAIA BATIS.)

On each side of the superior part of the abdomen, at a short distance from the spine, the sympathetic nerve forms an unequal oblong ganglion of a red-ash colour; it gives off both large and very small nerves, having this appearance, to pass on the mesentery, communicate with branches of the par vagum, and accompany the mesenteric arteries to the viscera. Some filaments are distributed about the testicles, and others pass towards the aorta; but these are too soft to be satisfactorily traced to their precise terminations.

The large ganglion communicates by a semitransparent tissue with a small one—this with the next, and so on to some distance down the spine; it communicates by the same tissue with the par vagum, and the large nerves collected from the spinal chord, which resemble the axillary plexus of the higher classes. It may be a question whether this semitransparent tissue be nervous; but as it connects small ganglia with each other, and with the large one, but little doubt can be entertained respecting its true character, notwithstanding the nerves proceeding from the large ganglion to the viscera have a different appearance.

The sympathetic nerve of this creature must be formed almost entirely for the abdominal viscera, as similar ganglia have not yet been observed in any other part of the body. There is, indeed, a ganglion attached to a branch of the fifth, and placed underneath the skin of the lower jaw, near each angle of the mouth, but it is almost transparent, and corresponds more with that of the gustatory nerve in some of the mammalia.

If the transparent tissue connecting the ganglia with each other and the spinal nerves be nervous, it may form very extensive communications; fishes of greater magnitude than that from which this plate was taken, may exhibit it in a more conspicuous manner.

This engraving is of the full size of a preparation made from a skate weighing upwards of thirty pounds. It is taken from the part just above the last gill; the stomach was divided longitudinally, and then had a portion removed from each cut edge, so that it might be narrowed as much as possible, for giving room for the delineation of the large ganglion of each side. On the right side, the nerves accompanying the mesenteric artery are more particularly shown, and some filaments forming communications with those of the left and the par vagum.

a. Stomach.

b. Testis.

1. Ventricular branch of the par vagum.
2. Posterior branch of the par vagum.
3. Large ganglion of the sympathetic nerve.

Fig. 1.

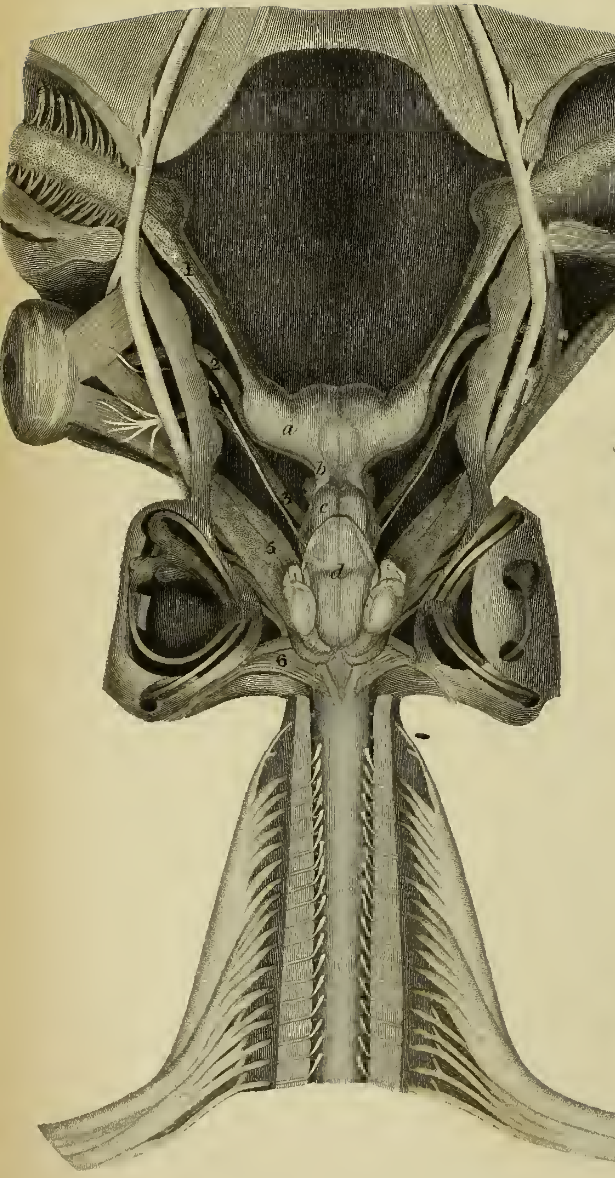

Fig. 2.

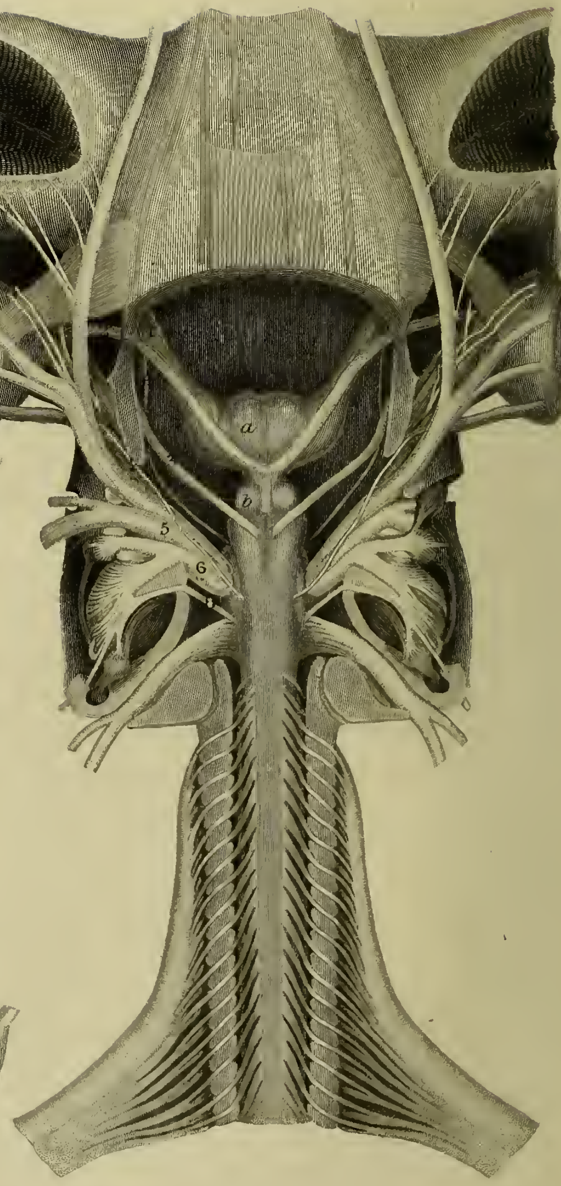

Fig. 3.

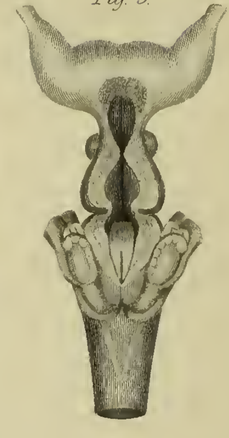

Fig. 4.

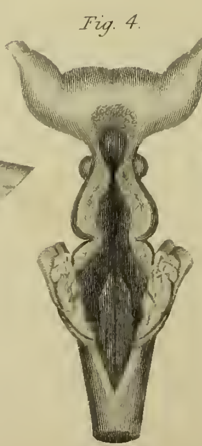

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PLATE X.

THE SKATE.

(RAIA BATIS.)

FIGURE I.

THE DORSAL ASPECT OF THE BRAIN AND SPINAL CHORD.

a. ANTERIOR lobes of the brain.

b. Pedicles of the anterior lobes, corresponding with the crura of the brain.

c. Optic lobes.

d. Cerebellum; its middle portion is smooth, but that on each side is convoluted.

e. Nose.

1. Olfactory nerve; it arises, or is continued from the anterior lobe; it passes out of the cavity of the skull, and forms a long ganglion over the nose, which gives off numerous branches to pass through holes in the membrane, corresponding with the cribriform plate of the ethmoid bone, to the membranous plaits or folds of the nose.

2. Optic nerve.

3. Third nerve passing to all the muscles of the eye, except the superior oblique and the abductor.

4. Fourth or pathetic nerve: it arises just beyond the posterior point of the optic lobe.

5. Fifth nerve; it appears to have two origins; one from the restiform body, the other from a pedicle or process of the lateral lobe of the cerebellum. There is an intermixture of different portions as in a ganglion.

6. Par vagum; it arises in a lengthened row of fibrils from the restiform body. This is the last of the cerebral nerves.

FIGURE II.

THE BASE OF THE BRAIN, AND THE VENTRAL ASPECT OF THE SPINAL CHORD.

a. Anterior lobes of the brain.

b. Mammillary eminences.

c. Nose.

1. Olfactory nerve.

2. Optic nerve; it proceeds from the optic lobe and mammillary eminence, and the pedicle of the anterior lobe; there is an interlacing of the nervous fibres just before the nerves separate.

3. Third nerve; it arises from the base in the track of the pyramidal body, a little behind the mammillary eminence.

4. Fourth nerve.

5. Fifth nerve; it arises from the restiform body and the lateral lobe of the cerebellum.

6. Auditory nerve; it is a portion of the fifth; it gives branches to the enlargements of the semicircular canals and the sack of the labyrinth, and communicates on this with the glosso-pharyngeal nerve.

7. Sixth, or abducent nerve; it arises from the base of the brain in the track of the anterior pyramidal body, and terminates in the abductor muscle of the eye.

8. Glosso-pharyngeal nerve; it arises just behind the upper portion of the par vagum: indeed, it would seem to be a part of the same, and only ascending from this to communicate with the auditory nerve before it reaches its destination. It communicates

with the auditory on the large sack of the labyrinth, and gives filaments to the termination of a semicircular canal; it then passes out to give filaments to the surface of the first and that of the opposite one of the adjoining division of the gills, and the membrane of the mouth.

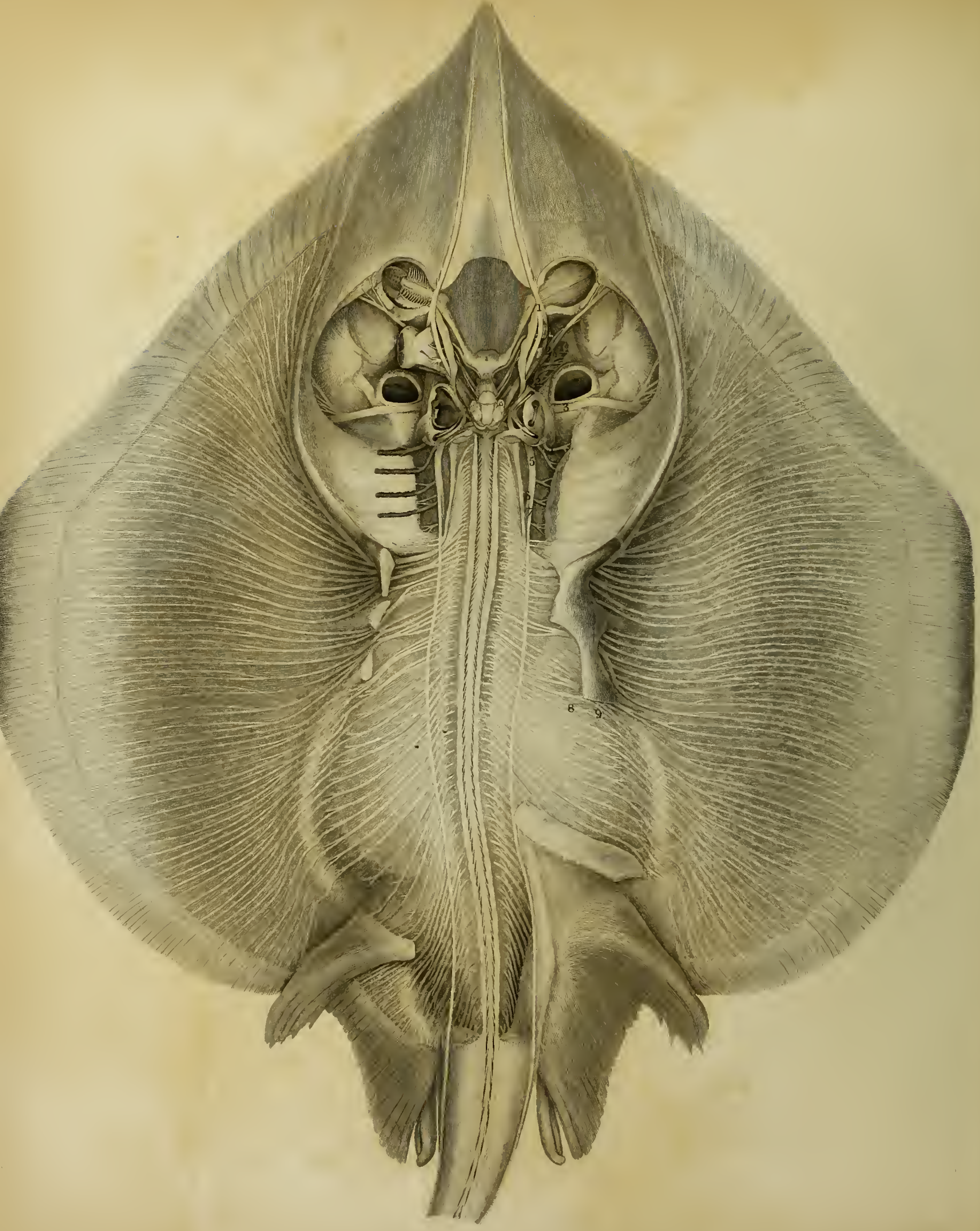
FIGURE III.

It shows the ventricle extending from between the crura of the anterior lobes into the optic lobes and the cerebellum. Parts of the lateral lobes of the cerebellum have been removed, and the middle lobe is seen opening into the ventricle.

FIGURE IV.

The middle lobe of the cerebellum has been removed for showing the ventricle throughout to the calamus scriptorius.

PLATE XI



Drawn by West

Engraved by [illegible]

London, Published by Longman & Co 1837.

PLATE XI.

THE DORSAL ASPECT OF THE NERVOUS SYSTEM OF THE SKATE.

(RAIA BATIS.)

THE olfactory nerve is seen passing to the nose and forming a large ganglion, which is perfect on the right side, but on the left has been partly removed for showing the cribriform membrane through which the nerves pass to the membranous olfactory plaits. On the right side, the optic nerve is seen passing to the eye; on the left, it has been removed for giving a better view of the branches of the fifth. The third nerve is seen passing to all the muscles of the eye, except the superior oblique and abducent. The fourth is seen passing to the superior oblique muscle. The fifth is seen giving off three principal trunks besides the auditory; the first passes in two divisions through the orbit, these become united at the anterior part of this cavity, and the nerve is then continued forwards, giving branches to the cellular structure in its course towards the end of the snout: the second trunk passes on the fore part of the muscles of the jaw, gives a large branch which distributes branches on these muscles and the upper and lower lips; it gives a large branch to the cellular structure on the ventral surface of the snout, this also gives branches to the upper lip; it gives a large branch to the cellular structure at the side of the head: the third trunk passes behind the muscles of the jaw, gives branches to these, and is distributed on the skin about the mouth and gills; one of its branches forms a ganglion, which gives off filaments to terminate about the under lip. The auditory portion of the fifth passes to the ear, and gives branches to the sacks containing the cretaceous matter and the globular enlargements of the semicircular canals, whilst a nerve, similar to the glosso-pharyngeal, communicates with it on the large sack, and gives filaments to the termination of a semicircular canal, and then passes outwards to give filaments on the surface of the first and the corresponding one of the second division of the gills, and terminates on the membrane of the mouth. The par vagum is seen passing to the gills, giving filaments to the muscular appendages of these, and then sending a large branch to distribute filaments to every part of the opposite surface of each division, except the first; it sends a branch anteriorly to the stomach, which communicates with the sympathetic; it sends a large branch posteriorly to pass underneath the muscles of the back, and give filaments to these in its course; this branch lies upon and crosses the spinal nerves; near the tail it emerges from underneath the muscles, and passes just under the skin to the extremity of this part; it has been carefully examined, but communications between it and the spinal nerves have not been satisfactorily observed.

The spinal marrow is seen gradually decreasing as it extends towards the tail. Each posterior bundle of the spinal nerves terminates in a ganglion, and is joined by a corresponding anterior bundle; it is then continued outwardly, and becomes connected with several others from the upper part of the spinal marrow, to form a large mass of nerve somewhat like the axillary plexus. Lower down other junctions take place, but these are smaller, being composed of fewer nerves. The nerves thus formed pass forward, and then divide into branches for the anterior and posterior surfaces of the body. The posterior divisions send off small branches which pass between the long cartilaginous ribs or processes, and supply the muscles and skin. The anterior division passes forward in a similar manner, and, after sending up branches to the muscles of the chest, and others to those of the abdomen, is continued forward over the anterior surface of the body, and divides into branches to be distributed in a similar manner to those on the posterior part.

1. First trunk of the fifth, formed of two parts.
2. Branches of the second trunk of the fifth.
3. Third trunk of the fifth.
4. Glosso-pharyngeal nerve.
5. Trunk of the par vagum.
6. Ventricular branch of the par vagum.
7. Dorsal branch of the par vagum.
8. One of the spinal nerves.
9. The branch of the spinal nerve passing to the muscles, &c., at the anterior or under surface of the body. All the other spinal nerves divide in a similar manner, except that when several, as in the upper part, join together into a trunk, part of the

trunk thus formed passes to the anterior or under surface, and then divides into branches as it does on the posterior surface.

The head of a skate, recently dead, is well suited for making observations on the difference between a sensiferous and motiferous nerve, as the living action of the muscular fibres can for some time be made apparent by irritating their nerves.

The glosso-pharyngeal nerve communicates with the portion of the auditory on the sack of the labyrinth, and, after giving filaments to the surface of the first, and the corresponding one of the second division of the gills, terminates on the membrane of the mouth. This nerve, on being touched near its origin in a recently dead animal, immediately produces a contraction of the muscular appendages of the gills. Does it, therefore, communicate with the auditory nerve for the purpose of imparting contractile power to the sack containing the cretaceous matter, or is it for allowing this portion of the gills to receive sonorous impulses, and communicate them to the nerve spread on the sack, and thus act in a modified manner like the membrane of the tympanum? It may be presumed that it has also sensiferous qualities, as it and the auditory nerve are mixed together on the sack. It may be a question whether the cellular structure in the snout is only for enhancing the sensibility of this part, or whether it has electrical properties like the peculiar organs of the torpedo?

The welfare of all creatures is consulted by their adaptation to peculiar situations; so that whilst every place is more or less inhabited, nothing capable of affording aliment to suit each species is lost. It is true, indeed, that some individuals need not be thus confined, and others may in time be gradually accommodated to fresh situations; but the greater part die prematurely, notwithstanding every care has been bestowed on them after a removal from their destined habitations. Similar limitations and exceptions exist with respect to the proper kinds of food. One animal is fitted for the coarsest diet, whilst another, that could not be thus well nourished, preys on that which has assimilated this refuse food to its digestive capacity. The stomach may, however, be gradually brought to digest what is not natural to it; but the change, like that of situation, is generally unfavourable to the well-being of the animal.

Fishes inhabit water in every part of the globe, and occupy it at different depths, and are required to subsist on various sorts of nourishment; and as they must therefore have different capacities, they must have corresponding variations in the structure of their bodies. The appetite for food appears to be their predominant desire, and providing for its gratification to form their chief occupation; and as this is very voracious, they must be constituted not only with a peculiar digestive apparatus, but with subtlety for taking their prey, and strength for pursuing it, as well as for defending themselves against the attacks of their adversaries. To the varying functions of the different organs the nervous system is appropriately adapted. When the sense of smelling is most conducive to their convenience, as in the skate, there is a capacious nose, large olfactory nerves, and large anterior lobes of the brain; and when seeing is more advantageous, as in the cod, the anterior lobes are smaller, and the olfactory nerves decrease in the same ratio; the eyes are consequently large, and the optic nerves and parts of the brain from which they originate are commensurate with them. Besides the different form and size of the several portions of the brain generally existing, it is furnished with additional lobes, when extraordinary powers are necessary. The structure of the brain is soft, as compared with that of the human, even after its immersion in alcohol; and so is that of the spinal marrow and nerves. The spinal marrow generally extends from the brain to the tail; its structure is more open than in man, and contains a less quantity of medullary matter, in proportion to the membrane. On viewing a transverse section after it has been kept for some time in spirits, a cellular appearance is very remarkable.

The progressive changes in the human fœtus during uterine existence, and their comparison with the perfect state of various creatures, have occupied considerable attention *. Such opinions may, however, have been founded on these inquiries, as are indeed novel, and to some extent probable, but in reality not so plain as their pretensions, on a superficial examination, seem calculated to determine. It is stated that the human brain and spinal marrow, in their early stages, pass through the permanent forms of those of fishes. The varying size and shape of the anterior lobes are compared with the anterior prominences of the brain of the human fœtus, the optic lobes with the next, and the cerebellum with the most posterior. This is the comparison of a creature in every respect perfect, with the very diminutive and immature parts of a fœtus; it is a comparison of the well-defined external and internal shapes and perfect organisation of the mature brain and spinal marrow of fishes, with the diffluent matter contained in the membranes within the cranium and spinal canal; and although in time an immersion in alcohol gives this some consistence, the reality, as it exists in the living fœtus, is not altered. If the several parts of the brain of fishes be examined separately, it will be

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* For particular information on this subject the reader is referred to the elaborate works of Serres and Tiedemann.

found that the varying form of the anterior lobes, which are commensurate with the olfactory nerves and the nose, does not countenance any just comparison with the anterior prominences of the brain of the human fœtus. The optic lobes are compared with the prominences representing the quadrigeminal bodies. These are termed optic lobes, because they are supposed to give origin to the optic nerves. In the cod, the optic nerves arise from the mammillary bodies as well as from the optic lobes; and the mammillary bodies are large in proportion to the size of the optic nerves, and not to that of the brain. In the turtle, the optic tracts are the continuation of the thalami, although they communicate with the optic lobes. In the goose, the optic tracts are extended from the optic lobes, and have an acquisition from the thalami. In man, and most of the mammalia, the optic tracts are evidently continued from the thalami, and their functional relation may be assumed from morbid anatomy; for in continued blindness of one eye, the optic nerve has been found much smaller than that of the sound organ; the optic tract, as it passed on the opposite side, has been withered in the same manner; and the thalamus, from which this proceeded, has been flattened, and not so full and plump as that from which the sound nerve originated. The inference to be drawn from such facts is this—that other parts of the brain besides the optic lobes are necessary for vision in the four superior classes of animals; and if similar ones exist, they are very differently placed. These considerations, apart from the imperfection of structure, tend very much to invalidate the pretensions to a comparison between the brain of fishes and that of the human fœtus, at least as far as they depend upon external appearances.

Doctrines founded on the location and external resemblances of parts, without a sufficient regard to their internal structure, are to be received with proper limitations, otherwise they must be extremely fallacious; but notwithstanding the necessity of this precaution in the present instance, it must be allowed that much curious and interesting information has been elicited respecting the gradual development of the nervous system in the fœtal progress of many animals. Some slight approximation of external appearance between individuals of separate classes, in different stages of growth, may be contended for, but not enough for establishing any further identity with each other. The comparison of the vesicular form of the fœtal brain of one creature with that of another in a similar state, may be properly admitted, although one have existed only a few days, and the other several weeks, but it never can be when it is made with the completely organised brain of a perfect being.

If ingenuity could have satisfactorily reconciled the incongruity in the comparison of perfect with imperfect structures and other differences, it might have established the existence of a series of most curious coincidences ; but it could not have countervailed the fact, that each creature was separately created, and had a law implanted on it, by which the generative organs should determine the reproduction of its like, and the quickened germ preserve a particular order of development of its various parts, in the progress of the fœtus to maturity.

The pretensions to uniformity in some particular stage, during the fœtal progress of different classes of animals, having been briefly noticed, it may be necessary to inquire into those relating to a similarity of arrangement in the perfect state of the nervous system.

Although the animal kingdom has been formed from a few primary substances, yet each species has a peculiar construction, not only in mechanical arrangement, but in the varied combination of elementary particles; so that the several parts are not only different in external character, but in such particular properties as are appreciable by the taste and smell. There is, in almost every species, some variety in the organs composing it; there is an adaptation of the nervous system for exciting and harmonising the different organs, and a peculiarity of the brain for imparting a degree of intelligence necessary for directing each creature to a determinate end. If one part therefore varied, others must be modified to correspond with it.

The more carefully the nervous system is examined, the more difficult it becomes to reduce to one standard the forms of any of its several parts in all animals. It is not surprising that it should be so, when it is considered how different the stations and pursuits of different creatures are required to be, and, consequently, the arrangement and structure of the various organs of which their bodies are composed. It is, however, pleasing to see the similitude of so many portions of it displayed by comparative anatomy, even in only a part of the animal kingdom, the clearer and more ample development of the one confirming the more diminutive and dubious character of the other. It would have accorded with the wishes of man, with that longing after the attainment of perfect knowledge, to have been able to find a regular disposition of a principal portion of the nervous system of every animal, and in the rest a gradual rise towards the highest standard of perfection; but this position at different points fails to be realised, and must be deserted as untenable, if it is to be maintained by a strict adhesion to truth.

It seems to be agreeable to reason, as well as the usual established order of the creation, that there should be some uniformity in the construction, as well as the economy of the nervous system; for, although different individuals prey on each other, yet a means of defence or escape is frequently afforded them, and the reciprocal feelings of power and defencelessness could hardly be experienced and acted upon, if a similarity of perception did not exist, the kindly feeling of one towards another could not. For other purposes some similarity is required. If the uniformity of the nervous system be necessary for preserving a connection between the different kinds of animals, it may be asked whether it could be effected in any other manner than by a repetition of forms and shapes, or whether there be any thing in its elementary state, by which such an arrangement could not be more extensively promoted ? This inquiry is attended with considerable difficulty, and, as in the ultimate disposition of parts in most of the works of nature, can only be glanced at.

Life is the essence of being, and gives peculiar properties to matter, which cease on its departure. The nervous element adds power to animate things, and exalts them according to the manner of its supply; this property may also be impaired or lost by its partial obstruction or removal.

The nervous matter of the centres appears in three forms, the cineritious and white parts of the brain and spinal marrow, and the ganglions. It is presumed that the element which actuates these is the same, and can be modified by each of them. The nerves are modifications of these substances, and are combined with the neurilema or other tissues for a convenient conjunction with the different portions of the body in which they terminate.

An approach to uniformity may be found in the employment of the nervous element for the whole animal creation. Omnipotence of conception could alone have selected it for such a comprehensive purpose, omnipotence of design could alone have modified and fashioned it to the bodies of so many thousands of creatures. The grand secret of uniformity lies in its adoption as a first principle. It is connected with the brain, the ganglia, and nerves ; and, by the different composition and shapes of these, becomes suited to the varied organs and their requisite and peculiar functions ; and at the same time affords a proper receptacle for the mind of man, and instinct or intelligence in animals, and accomplishes the mysterious conjunction of these with the corporeal frame.

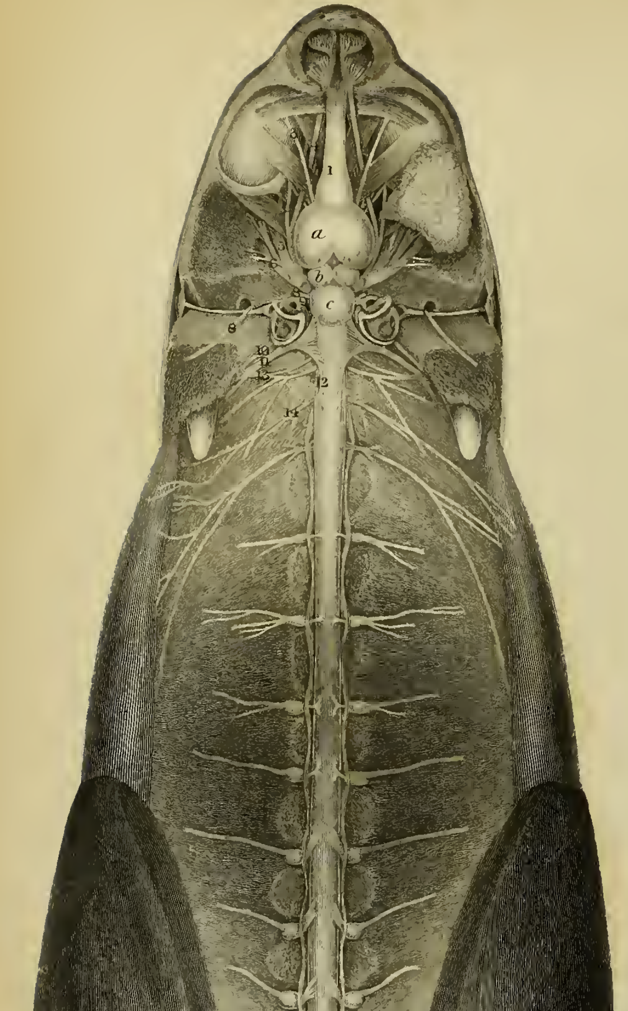
If the nervous element be esteemed the first principle in the economy of the nervous system, are the forms and shapes of its several parts to be included in a secondary one? The difference of some portions of the brain, whilst peculiar properties are frequently manifested in different animals, and the great similarity of others, whilst very similar powers are more generally required, the regularity of the fibres composing the internal structure, the defined situation and quantity of the white and grey matter, the different consistence of some of the ganglia and nerves, make it very probable that peculiar functions are determined by some particular arrangements. There is, however, considerable difficulty in acceding to this point, and it must be cautiously determined, for, if a single part be examined in the several classes of animals, it will be found that many variations of shape are for mechanical convenience, for its proper adaptation to a particular form either of the skull, or of organs subjected to motion. But from whence is the consideration of this subject to set out? It must not be from the entire nervous system of man, or any particular animal; for some portions of the brain of man are much more extensive than in animals, and in one animal than another; and, on the contrary, other parts are as much inferior. The reality and uses of some minute nerves in man might, on a superficial examination, be doubted, but for their correspondence with similar ones in animals which are ample and distinct. The nervous system of man may therefore be taken as the standard of perfection as a whole, and in many respects after its division into parts, but not in all. But, by way of illustrating this subject, it will be best to give an example of the varieties of the same part in different animals. In man, and some animals, the olfactory nerve is small, in others it is very large; the part of the brain giving origin to it, is proportionate to its size, but varies in shape in a great many instances in the four superior classes of animals, probably to suit the space allowed by the form of the skull. Before terminating in the Schneiderian membrane, the nerve generally assumes the appearance of a ganglion, which varies in extent to correspond with that of the cribriform plate, through which its branches are to pass; in some animals there is hardly any appearance of a ganglion, but only a slight ridge, at which the nerve seems to acquire a little difference. The form of the portion of brain from which the olfactory nerve arises, or that of the nerve itself or its ganglion, does not seem to be necessary for producing the sense of smelling; there may, however, be a peculiarity of the fibres, and a necessary proportion of white and grey matter, according to a principle, for modifying the sense and adapting it to the required purposes of each animal.

When the external form and general structure of animals are the same, a similar disposition of the nervous system, as of the other parts composing their bodies, would be obviously adopted. But this similarity of appearance, even in a considerable number of instances, cannot be assumed as an undeviating standard on which the nervous system of all animals must be founded. Such a determination is contrary to reason, for, if the most probable plan on which animals were originally constructed is duly considered, it will appear that each of them was separately fashioned on the nicest calculation, both as to the quantity and quality of every atom, not only of the nervous element, but of every other employed in its composition, otherwise the law which marks the particular character on the several parts of the body in the male and female, the bounds for the preservation of its species, its size and necessary degree of intelligence or instinct, could not have been imprinted on it. If the animal kingdom were designed for the prominent place it sustains, the forms and faculties of each individual must have been predetermined, and the nervous and other elementary substances afterwards proportioned to each other, and shaped for fulfilling the destined object. But the idea cannot for a moment be entertained, that a creature was to be made for a particular purpose, and that a mechanical uniformity of the nervous system was to be observed, from which such a deviation could not be effected, as would accord with the changes of the other parts and organs of which the body was to be composed.

The benevolence, which is so universally displayed throughout the arrangement of the nervous system, and which may be so truly appreciated in every part, could not have been manifested, if the plan, on which it is founded, had not been predetermined. For whilst the whole animal creation has been connected together by the varied use of similar means, and each creature has been suited to its peculiar state, it has at the same time been most appropriately fitted for an adequate share of enjoyment, notwithstanding the meanness of its form, its seeming helplessness, or the lowness and obscurity of its station. By a most careful and exact adjustment of every portion of the nervous system to the parts of the skeleton or other organs subjected to motion, it has been made with a special view of securing ease, if not of ministering to enjoyment. Without the most consummate skill in calculating the precise size and length, particularly of the spinal marrow and nerves necessary for their adaptation to moving parts, so as to prevent their compression or overstretching, misery must generally have resulted from every combination. When it can be so clearly demonstrated, that a nervous system, having the same essential properties, exists in every creature, and that it has been formed with so much care and nicety for the most beneficent purposes, it might be well if man would consider, that nerves similar to those with which his body is furnished, may be made instruments of the same pain as he suffers from cruelty or accidental injury, from want or neglect.

> Quidlibet audendi semper fuit æqua potestas;
> Scimus, et hanc veniam petimusque damusque vicissim:
> Sed non ut placidis coëant immitia, non ut
> Serpentes avibus geminentur, tigribus agni.

Fig. 1.



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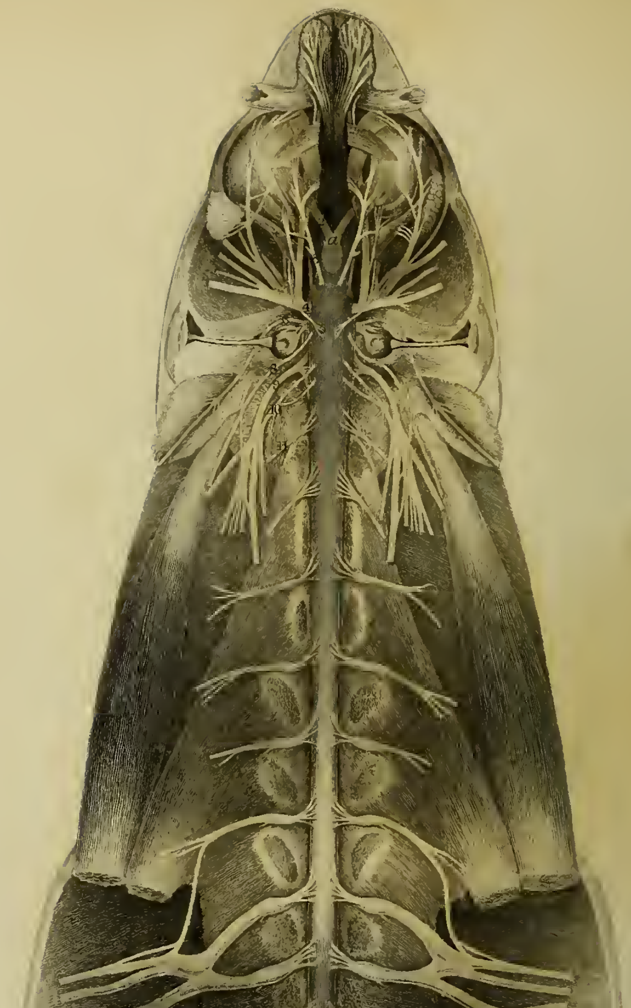

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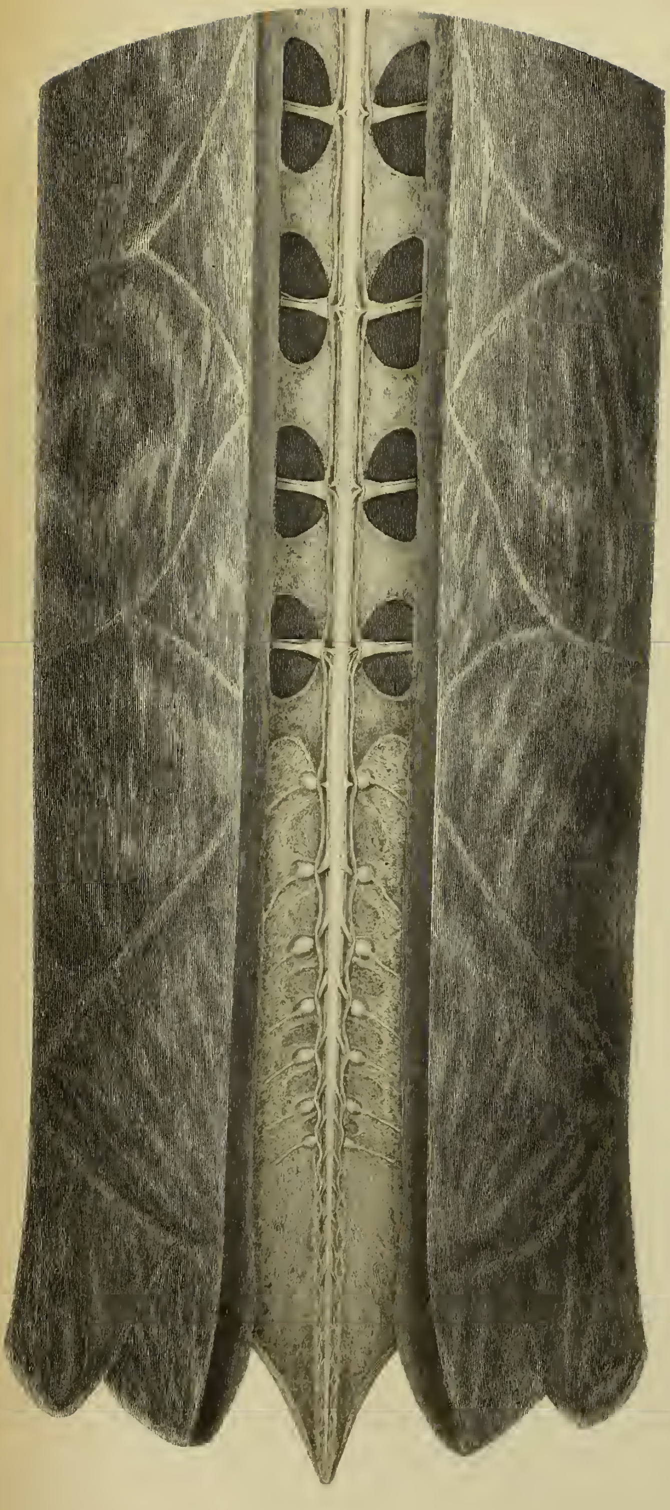

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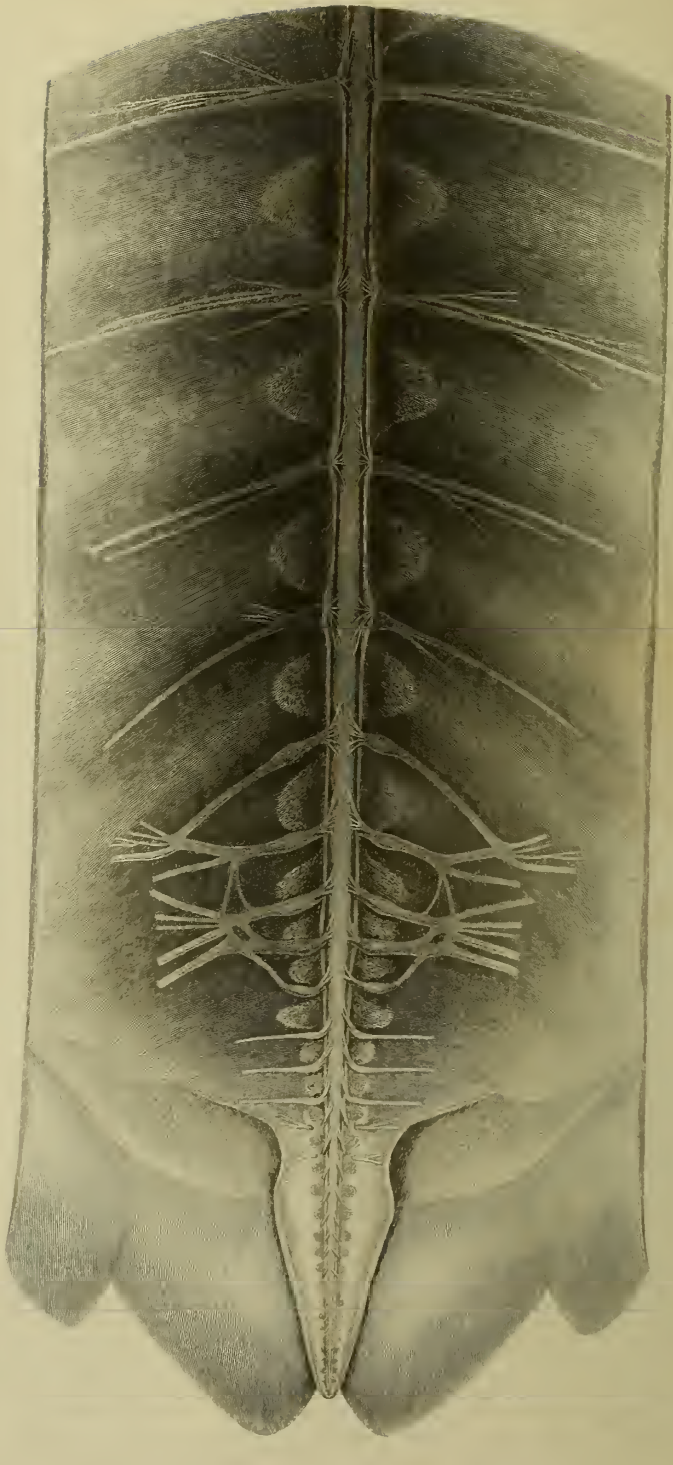

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PLATES XII. AND XIII.

THE BRAIN AND SPINAL CHORD OF THE TURTLE.

(TESTUDO MYDAS.)

FIGURE I.

DORSAL ASPECT.

THIS figure, and the first in the next plate, exhibit the summit of the brain and the posterior surface of the spinal chord.

a. Anterior lobes of the brain.

b. Optic or posterior lobes of the brain.

c. Cerebellum.

In the spinal chord there are not any posterior bundles to join the anterior of the two first cervical nerves. All the posterior bundles of the cervical nerves are seen much smaller than the anterior, those of the thoracic larger, and those of the sacral rather less.

1. Olfactory nerve continued from the anterior point of the anterior lobe, and passing to the nose, but not forming a ganglion, and terminating in coarse brushes on the Schneiderian membrane.

2. A branch of the first trunk of the fifth, joined by one from the third, to form ciliary nerves.

3. Fourth, or pathetic nerve, arising from the roof of the ventricle just behind the optic lobes, and passing to terminate in the superior oblique muscle of the eye.

4. First trunk of the fifth ; it passes forward, gives a branch to join one from the third nerve to form the ciliary nerves, passes underneath the attollent and superior oblique muscles of the eye, gives filaments to the upper eye-lid, and then enters the nose, where it becomes intimately united with a portion of the olfactory nerve, and terminates on the Schneiderian membrane.

5. Second trunk of the fifth ; it gives filaments to a muscle of the lower jaw, then passes on the floor of the orbit, gives filaments to the large lachrymal gland and the lower eye-lid, and divides into branches to terminate on the surface of the palate and upper jaw beneath the horny covering.

6. Third trunk of the fifth ; it gives branches to the muscles of the lower jaw, and then divides into branches, which terminate on the surface of the lower jaw beneath the horny covering.

7. A branch of the sixth nerve, given to the muscles which encircle the optic nerve, and are spread on the convex portion of the sclerotic coat.

8. Hard portion of the seventh nerve.

9. Auditory nerve.

10. Glosso-pharyngeal nerve.

11. Trunk of the par vagum.

12. Accessory nerve arising from the posterior surface of the spinal chord without joining any of the posterior bundles of the cervical nerves.

13. Ninth nerve.

14. First cervical nerve.

FIGURE II.

VENTRAL ASPECT.

This figure, and the second in the next plate, exhibit the base of the brain, and the anterior surface of the spinal chord.

a. Commissure of the optic nerves, and the connection with the part in the situation of the mammillary eminences. The pituitary gland has been removed.

The base of the brain is very smooth, and covered with a thick pia mater; so that the separation at the usual places of the several eminences is not distinctly observed before this is removed.

The anterior bundles of the nerves of the cervical portion of the spinal chord are much larger than the posterior; those of the thoracic much smaller; and those of the sacral rather larger. The first two cervical nerves are formed entirely of filaments from the anterior surface; the anterior trunk of the first gives filaments to the cervical muscles, and joins a branch of the ninth, and then gives filaments to the outside of the carotid artery, and terminates in the sterno-thyroid muscle, and one attached to the back of the œsophagus; the posterior trunk communicates with the posterior branch of the ninth, and terminates entirely in the muscles at the back of the neck; the anterior trunk of the second passes to a long muscle on the anterior part of the neck, and the posterior to others on the posterior. Sometimes only the first cervical nerve is formed entirely from filaments of the anterior surface of the spinal chord, and then the second has a filament from the posterior surface, and gives the branch to the skin of the face, instead of the third. A branch from the third cervical nerve may be traced through a portion of muscle to the skin of the face, and one from each of those below it to the skin of the neck.

1. Olfactory nerve.

2. Optic nerve.

3. Third or common oculo-muscular nerve, arising behind the mammillary eminence in the track of the pyramidal body; it gives a branch to join one from the first trunk of the fifth to form ciliary nerves, and then gives a branch to the levator, depressor, adductor, and inferior oblique muscles of the eye.

4. Fifth or trigeminal nerve, arising in the track of the pyramidal body.

5. Sixth nerve given to the abducent muscle, and those which encircle the optic nerve, and are spread on the convex portion of the sclerotic coat of the eye.

6. Hard portion of the seventh, arising from the restiform body; it crosses the external auditory meatus to give filaments to a muscle inserted into the angle of the jaw, and then passes to terminate on the constrictor muscle of the throat, which resembles in some degree the cutaneous muscle in the human subject; it communicates with branches of the cervical nerves given to the lower portion of the same muscle, and these are composed of filaments derived from both the anterior and posterior surfaces of the spinal chord.

7. Auditory nerve, arising from the restiform body; it divides into two principal

branches: the anterior passes to the termination of the anterior upright and horizontal semicircular canals; the other is spread on the sack of the labyrinth, after sending a branch to the termination of the posterior upright and the horizontal semicircular canals.

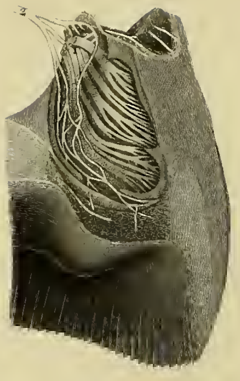
8. Glosso-pharyngeal nerve, arising from the restiform body; it passes underneath the cavity containing the sack of the labyrinth, gives filaments to muscles connected with the lingual bone, and terminates in the membrane of the pharynx.

9. Trunk of the par vagum, arising from the restiform body, and sending a filament to communicate with the auditory nerve on the sack of the labyrinth.

10. Ninth or hypo-glossal nerve, arising near the situation of the pyramidal bodies by two or three roots; it divides into an anterior and posterior trunk: the anterior terminates on the muscles connected with the lingual bone, after sending a branch to join one from the first cervical nerve, to terminate on the sterno-thyroid muscle and that attached to the posterior surface of the œsophagus; the posterior branch joins the posterior branch of the first cervical nerve.

11. First cervical nerve.

Fig. 1.



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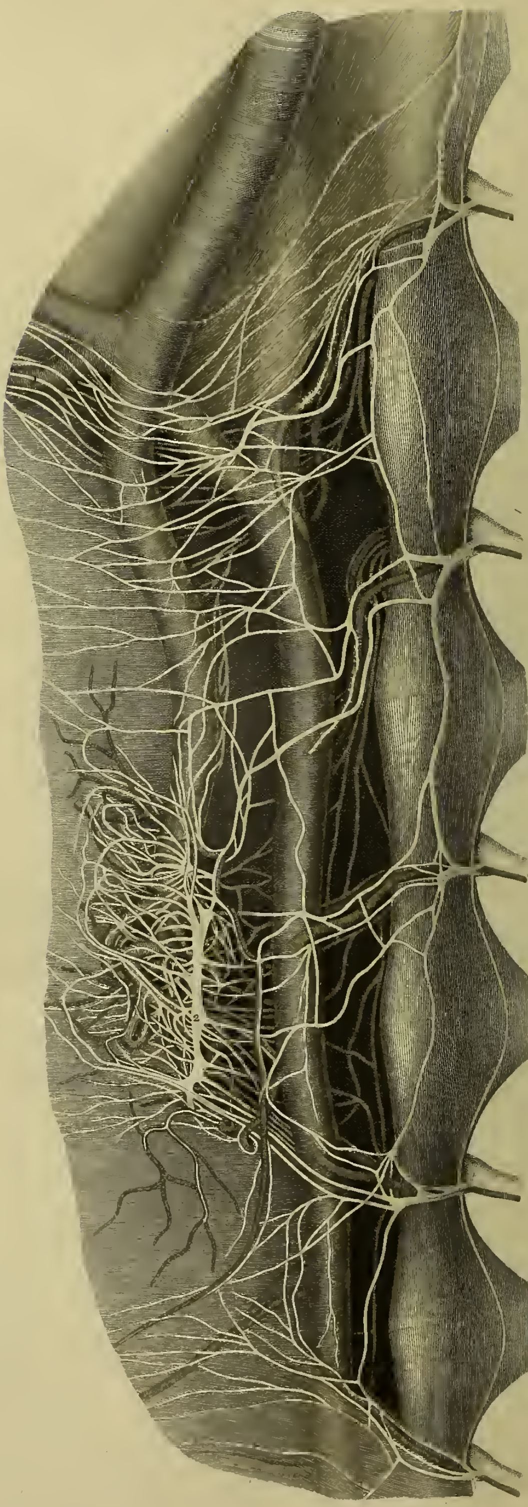

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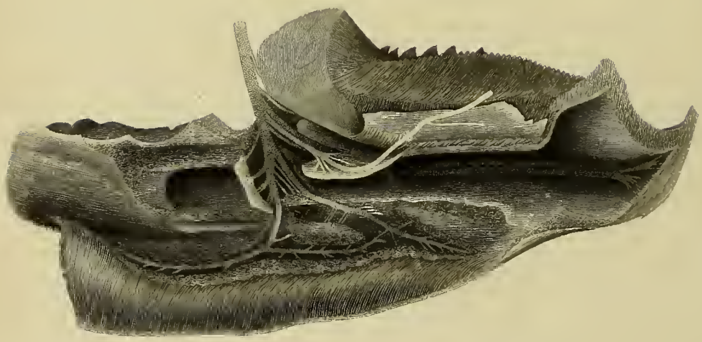

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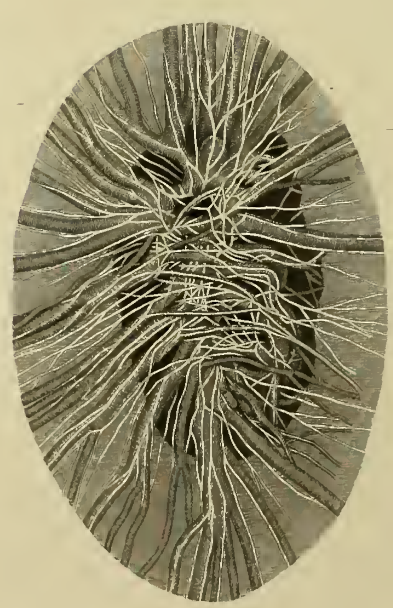

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PLATE XIV.

THE TURTLE.

(TESTUDO MYDAS.)

FIGURE I.

1. BRANCHES of the olfactory nerve are seen distributed on the Schneiderian membrane, covering the septum of the nose.

2. First trunk of the fifth connected with the olfactory nerve; it becomes divided into several branches, some of which are seen passing on the anterior part of the Schneiderian membrane, and then through portions of bone, to terminate beneath the horny and membranous coverings of the anterior part of the nose; the others are seen passing upon the Schneiderian membrane covering the septum, and then through perforations in the palate to the surface between the bone and horny covering at the anterior part of the palate and beak.

FIGURE II.

THE SAME.

When the third trunk of the fifth has entered the jaw, it is seen distributing branches on a membrane investing a cartilage situated within the lower jaw, and then giving off filaments to the parts beneath the horny covering: and sending two large branches to a portion of muscle analogous to the mylo-hyoideal, which is connected with and forms the most anterior part of the constrictor muscle of the throat, and resembles the cutaneous muscle in man; it is seen sending a branch also to the membrane of the mouth.

It is probable that the connexion of the nerves with the membrane, and the position of this on the cartilage within the jaw, produce a peculiar and necessary degree of feeling, and at the same time prevent shocks which would otherwise be experienced in the forcible adaptation of the hard and horny jaws.

FIGURE III.

THE SAME.

This figure represents the branches of the splanchnic nerves in their passage, with the branches of the mesenteric artery on the mesentery towards the intestines.

FIGURE IV.

THE SAME.

This figure represents the sympathetic nerve of the left side, and its termination in the visceral nerves.

1. Branches from each side of the dorsal ganglion of the sympathetic and the prolongation, to accompany the branches of the cœliac artery to the stomach.

2. A large and intricate plexus in the place of the semilunar ganglion; it sends branches to communicate with the renal plexus, and then gives off numerous filaments to accompany, for the most part, the branches of the mesenteric artery to the mesentery and intestines.

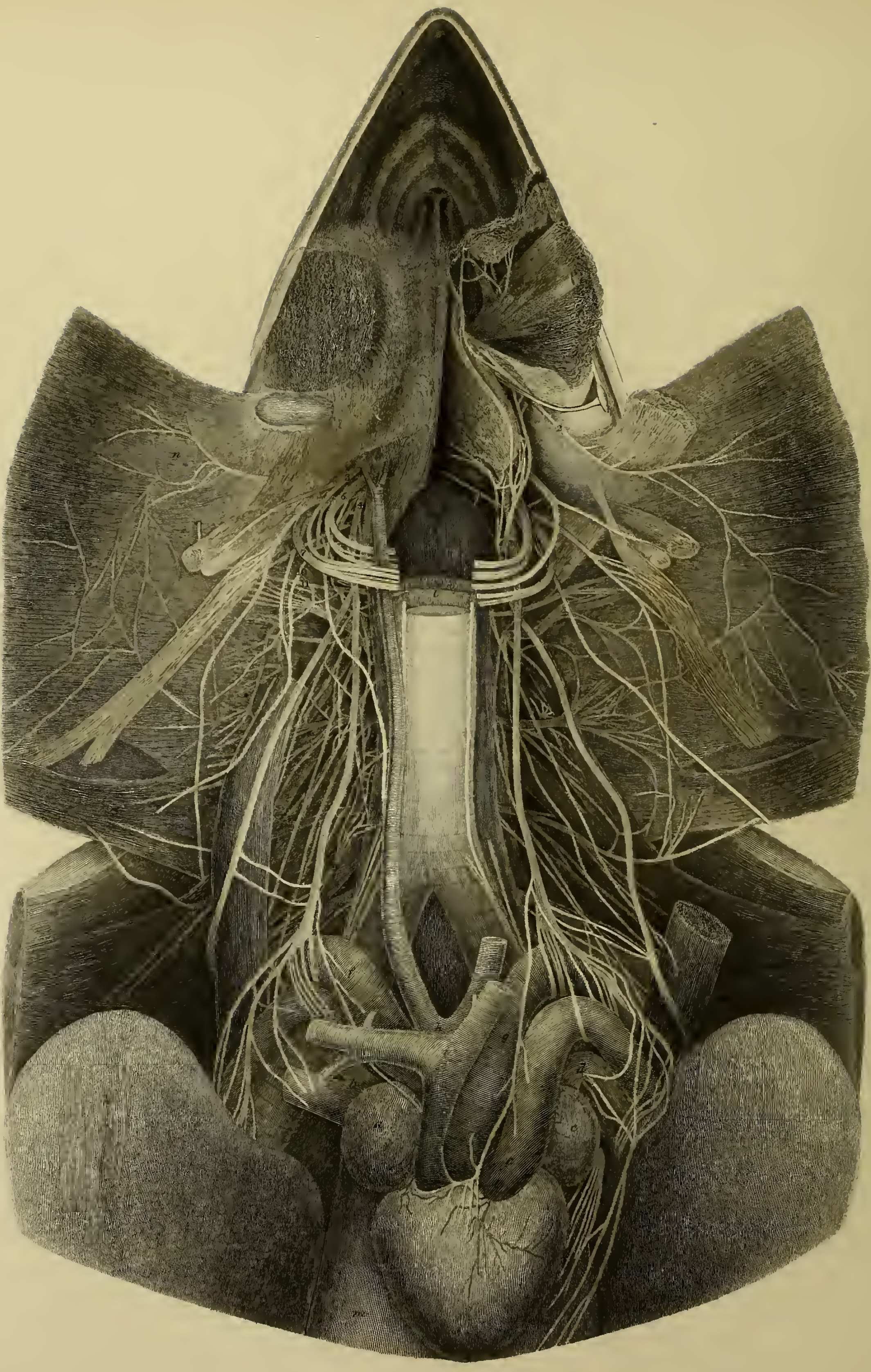

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PLATE XV.

THE SYMPATHETIC NERVE OF THE TURTLE.

(TESTUDO IMBRICATA.)

In this subject, the sympathetic nerve of each side formed a distinct trunk, but communicated with that of the par vagum by branches. From its upper part, one branch passed forward along with one of the divisions of the carotid artery in a canal at the base of the skull, gave a filament to the hard portion of the seventh, and communicated with a branch of the second trunk of the fifth, which terminated on the posterior part of the palate. Another branch passed with the other division of the carotid artery, into the reticular sinus, close to the external auditory meatus, and communicated with the ninth, the par vagum, the glosso-pharyngeal, and the hard portion of the seventh.

The trunk of the sympathetic nerve in this subject, is very similar to that of the par vagum, except that it has a somewhat more red and close appearance at its superior part, and near the first thoracic ganglion. The branches belonging to the sympathetic, and those belonging to the par vagum, could be more clearly determined than in the Testudo Mydas, which has both these nerves generally coalescing.

a. Right auricle.
b. Veins returning blood to the right auricle.
c. Left auricle.
d. Left pulmonary vein, the right has been removed.
e. Pulmonary artery.
f. Right aorta.
g. Left aorta.
h. Division of the carotid arteries.

i. Division of the subclavian arteries.

k. Lungs.

l. Œsophagus.

m. Stomach.

n. Constrictor muscle of the throat, corresponding with the cutaneous muscle in man.

1. Second trunk of the fifth nerve.

2. Hard portion of the seventh joining branches of the cervical nerves.

3. Glosso-pharyngeal nerve, giving a branch to the hyo-maxillary muscle.

4. Par vagum.

5. Laryngeal branch of the par vagum.

6. Recurrent nerves of the par vagum.

7. Ninth nerve.

8. Sympathetic nerve.

9. A long branch from the thoracic ganglion of the sympathetic passing up the neck, giving filaments to the surrounding parts, and communicating with the five superior cervical nerves, and again with the sympathetic, just before the entrance of this into the head.

10. First cervical nerve.

11. Second cervical nerve.

PLATE XVI

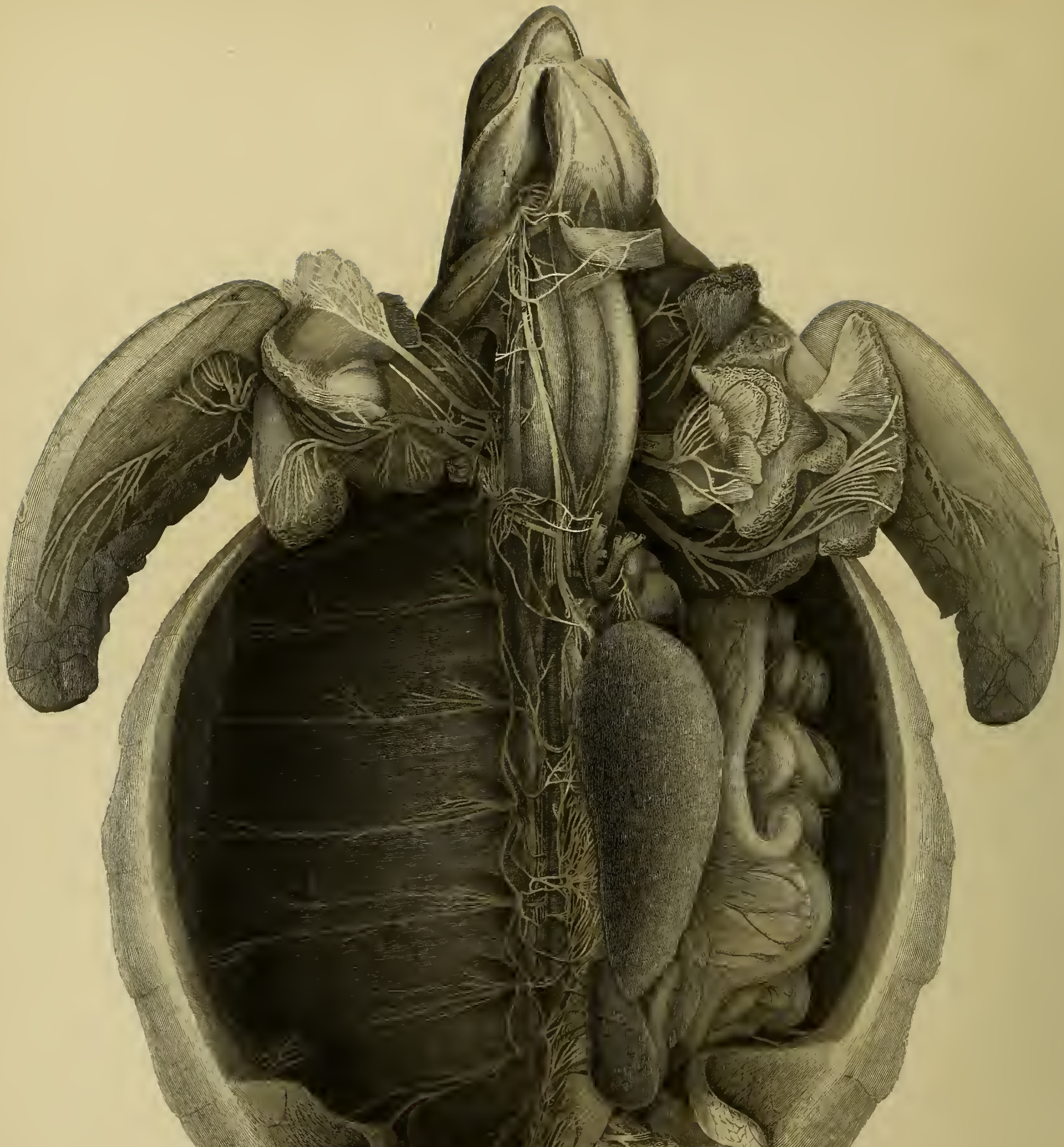

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PLATE XVI.

A GENERAL VIEW OF THE NERVES OF THE TURTLE.

(TESTUDO MYDAS.)

On the right side, the bones and muscles of the shoulder, and pelvis, have been almost altogether removed for allowing a view of the nerves.

1. Hard portion of the seventh nerve.

2. Trunk of the par vagum; on each side it sends a large branch to the larynx, and smaller branches to the pharynx and œsophagus; at the bottom of the neck, it leaves the sympathetic nerve; it then gives off recurrent branches to wind round each aorta to the œsophagus and trachea; it sends a branch on each side to the ventricles of the heart, and others along the large vessels towards the auricles; and many branches to each lung and the stomach.

3. Laryngeal branch from the right trunk of the par vagum; it gives branches to the muscles of the glottis, the membrane covering this, and to the œsophagus; also one distributing filaments on the carotid artery and surrounding parts, and then rejoining the trunk of the par vagum.

4. Recurrent branches of the right trunk of the par vagum to the trachea and œsophagus.

5. Glosso-pharyngeal nerve; it gives a branch to the hyo-maxillary muscle arising from the lower jaw, and inserted into the posterior corner of the hyoid bone, and the side of the pharynx, and then terminates on the membrane of the fauces covering the pharynx and tongue.

6. Anterior trunk of the ninth nerve; it gives branches to the genio-hyoideal muscle, the genio-glossal, and the hyo-glossal.

7. A nerve from the ninth giving branches to a long muscle analogous to the sterno-mastoid, and then sending a branch to join one from the first and second cervical nerves, and terminate on the sterno-thyroideal muscle, one attached to the posterior surface of the œsophagus, and one at the side of the neck.

8. Sympathetic nerve passing to the first thoracic ganglion; it sends up branches to communicate with the cervical nerves; those at the upper part of the neck are delicate and traced with difficulty, they do not enter a canal with a vertebral artery, as in mammalia and birds, but pass on the outside of the spine; it communicates with the nerves about to form the axillary plexus, also with the trunk of the par vagum, and sends many filaments on the arteries. The prolongation from it through the thorax communicates or coalesces with the ganglia of the dorsal nerves, but the anterior branch of each intercostal artery passes through or is embraced by this union. The prolongation frequently consists of a thick branch and a very fine one, and passes down to each succeeding ganglion, but neither of them passes behind the neck of each rib as in birds. It gives many small branches to the connecting membrane of the viscera, but the principal branches of each side form two intricate plexuses, which are in the place of the semilunar ganglia; the superior or smaller portion follows the branches of the cœliac artery to the stomach, the lower or larger the branches of the mesenteric artery to the intestines. Other branches pass from the sympathetic to the kidney, and the spinal nerves keep sending filaments towards this part, which seems to be the situation of the prolongation, and it is continued down to the side of the rectum, communicating with all the spinal nerves until their extreme minuteness prevents their further continuation from being easily followed.

9. First cervical nerve. Some of the cervical nerves are seen passing to the muscles and skin of the neck; those of the axillary plexus to the muscles and skin of the anterior extremity; those of the dorsal region principally to enter into the structure of the great shell; some of the lowest dorsal, the sacral, and caudal, are given to the muscles and skin of the posterior extremity, and the generative and contiguous parts.

10. Fifth cervical nerve. This, with the two next and the first dorsal, form the axillary plexus, from which many branches proceed to the large muscles of the shoulder, and arm, and the skin; besides these there are three large nerves, somewhat resembling the median, the spiral, and the circumflex.

11. Median nerve: it descends and divides into large branches, which pass into the substance of the hand, and give branches to the tendinous and muscular parts, and send others towards the skin in the form of digital nerves.

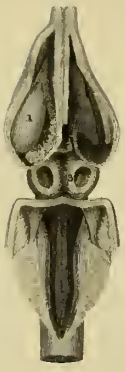
12. Spiral nerve; it gives some muscular branches in its course, and passes round to the outer side of the arm-bone, and divides and sends a branch through the outer condyle to join another, which is the principal continuation of the nerve, to terminate on the skin at the outer margin and back of the hand.

13. Circumflex nerve; it passes upwards beneath that muscle resembling the broadest of the back, and gives a branch to the larger teres muscle, and is then directed downwards to terminate on the skin at the back of the arm.

14. Ninth dorsal nerve; from this and the tenth, the nerves representing the anterior crural, obturator, and other nerves, usually proceeding from the lumbar, are given off; these are distributed on the muscles and skin connected with the superior part of the pelvis and thigh.

15. Sciatic nerve; it is principally formed by the eleventh dorsal and first sacral nerves; it however communicates with the tenth dorsal and second sacral; it divides into two principal parts, one of which gives branches to the muscles of the thigh, and is continued on the under surface of the foot, and terminates on the skin like digital nerves; the other, after giving off some muscular branches, passes to the skin, &c., at the upper surface of the foot.

Fig. 1.



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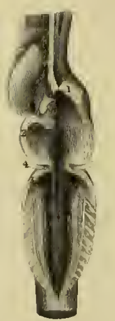

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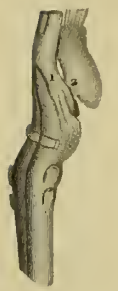

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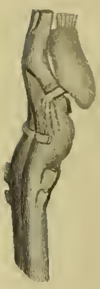

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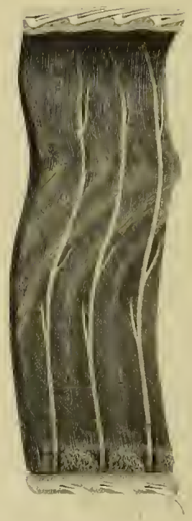

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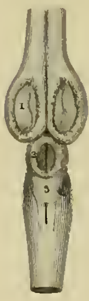
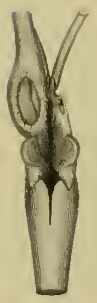


Fig. 8.



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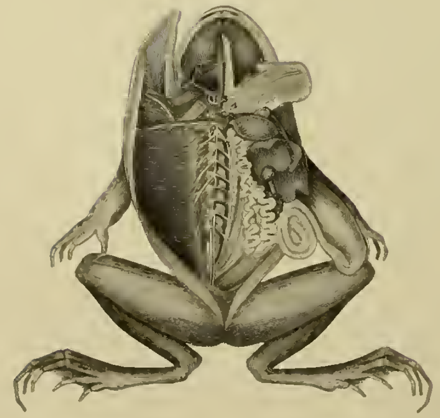

Fig. 6.

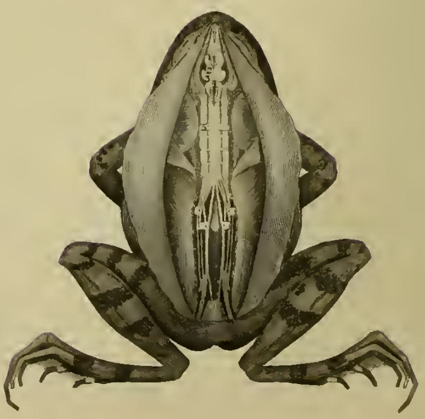

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PLATE XVII.

FIGURE I.

THE BRAIN OF THE TURTLE.

(TESTUDO MYDAS.)

1. STRIATED body, and a lesser oblong eminence seen on opening the lateral ventricle; on the left side the choroid plexus is seen passing through an opening in the septum, to communicate with that of the right side; part of the striated body has been removed on the right side.

2. Thalamus of the optic nerve.

3. Optic lobe and ventricle continued forward under the thalami, and forming a resemblance of the third ventricle, and then backwards into the cerebellum, and to the calamus scriptorius.

FIGURE II.

(THE SAME.)

1. Cut surface, from which the striated body has been removed; it is the crus of the brain, and is somewhat connected with the commissure of the optic nerves: the thalamus on this side has been cut off at its connection with the optic tract.

2. Optic lobe, from which more has been removed than in the preceding figure.

3. Cerebellum, from which more has been removed than in the preceding figure; two longitudinal bands are continued on from the base of the optic lobes, and terminate

near the calamus scriptorius, by being implanted into the anterior portion of the oblong medulla; on each side of these, others less distinct may be observed.

4. Fourth nerve.

FIGURE III.

(THE SAME.)

1. Optic tract, principally derived from the thalamus, but also communicating with the optic lobe.

2. Crus of the brain passing above the optic tract, but communicating somewhat with it and the part surrounding the infundibulum.

FIGURE IV.

(THE SAME.)

A portion of the optic nerve has been removed; the crus of the brain is seen passing from the anterior lobe to the oblong medulla.

FIGURE V.

THE FROG.

(RANA TEMPORARIA.)

This figure shows the nerves as they are distributed on the anterior or inferior part of the body.

1. A branch from the ganglion joining the par vagum ascending to communicate with a branch of the fifth, passing to the palate.
2. Trunk of the par vagum.
3. A nerve resembling the glosso-pharyngeal to the throat.
4. Hypo-glossal nerve given to the tongue.
5. A large nerve in the place of the axillary plexus.

6. Sympathetic nerve, formed from branches of the spinal nerves, which communicate with each other before they terminate on the viscera.

7. One of the pearly bags, or vesicles, connected with the nerves at their exit from the spinal canal.

FIGURE VI.

(THE SAME.)

This figure shows the brain, and posterior or superior surface of the spinal marrow. There are the same parts as in the snake.

1. Anterior lobes of the brain from which the olfactory nerves proceed.

2. Thalami of the optic nerves.

3. Optic lobes.

4. A narrow transverse band, which is the cerebellum, and behind this the ventricle at the calamus scriptorius.

5. A large nerve, instead of the axillary plexus: it is formed of an anterior and posterior bundle, the posterior having a ganglion attached to it. The cauda equina is seen forming the nerves of the lower extremities.

6. Anterior crural nerve.

7. Sciatic nerve: some of the white vesicles are seen, which are supposed to contain cretaceous matter.

FIGURE VII.

THE BRAIN OF THE SNAKE.

(BOA CONSTRICTOR.)

1. Striated body and oblong eminence near the middle line, seen as in the turtle, on opening the lateral ventricle.

2. Optic lobe opened.

3. Cerebellum extending over the ventricle at the calamus scriptorius: the sides of the ventricle have been rather too much separated.

FIGURE VIII.

(THE SAME.)

In this figure are seen the commissures of the optic nerves, in which the tracts join; the nerves do not cross by one's being super-imposed.

1. The cut portion of the crus of the brain from which the striated body has been separated.

FIGURE IX.

(THE SAME.)

The spinal chord is continued quite to the end of the tail, and has cineritious matter within it, similar to that in mammalia. It gives off anterior and posterior bundles of nerves; but their roots are very close to each other, and there is a ganglion attached to the posterior. At the anterior point, the anterior bundle becomes united with it: each anterior bundle is rather larger than the posterior.

Fig. 1.

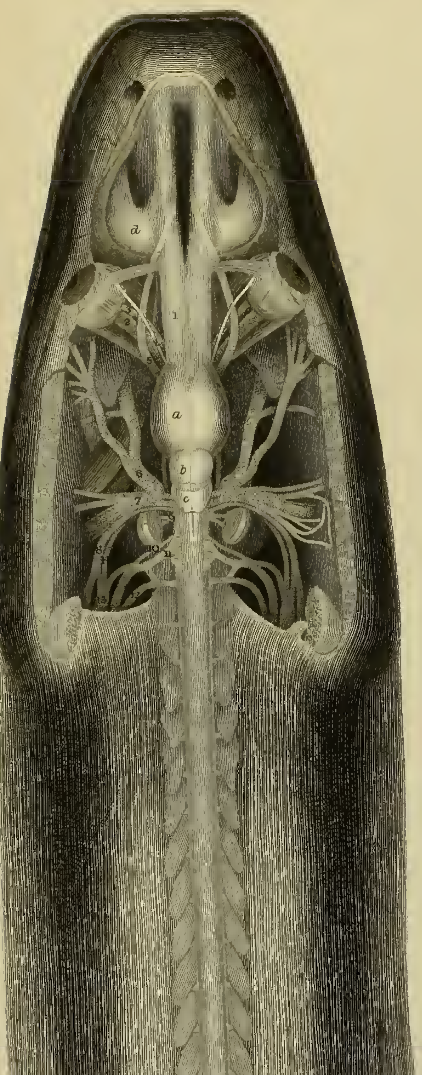

Fig. 2.

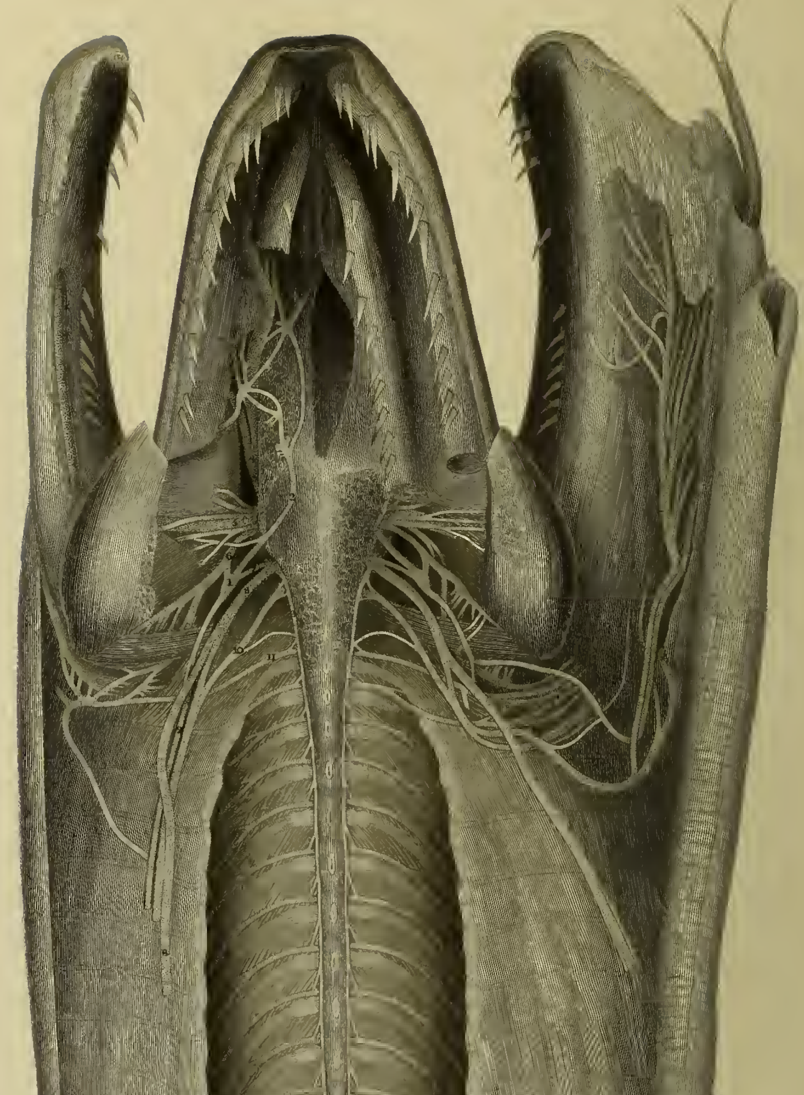

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PLATE XVIII.

FIGURE I.

THE ORIGIN OF THE CEREBRAL NERVES OF THE SNAKE.

(BOA CONSTRICTOR.)

THE figures of this and the following plate are the exact size of a snake nine feet long.

a. Anterior lobe of the brain.

b. Optic lobe.

c. Cerebellum.

d. Schneiderian membrane of the nose.

1. Olfactory nerve; it is fibrous, and different from the soft texture of the brain; it is joined by the first trunk of the fifth near its entrance at the nose, and the branches proceeding from it are then distributed over the Schneiderian membrane.

2. Optic nerve.

3. Third or common oculo-muscular nerve cut short.

4. Fourth nerve given to the superior oblique muscle of the eye.

5. First trunk of the fifth; it passes forward first within the cranium, then into the orbit, and from this part to the Schneiderian membrane, on which it becomes connected with the olfactory nerve.

6. Second trunk of the fifth.

7. Third trunk of the fifth.

8. Hard portion of the seventh nerve.

9. Auditory nerve.

10. Glosso-pharyngeal nerve.
11. Trunk of the par vagum.
12. Ninth nerve.
13. Ganglion of the sympathetic nerve, as in 1 Fig. 2.
14. A branch of the sympathetic nerve passing to the palatine nerve, as in 2 Fig. 2.

FIGURE II.

THE CONTINUATION OF THE CEREBRAL NERVES.

1. Ganglion of the sympathetic nerve, situated near to and connected with the trunk of the par vagum.

2. A branch of the sympathetic nerve passing some way in a canal at the base of the cranium, and forming a small ganglion with a branch of the second trunk of the fifth; it sends filaments to the membrane covering the posterior part of the mouth and palate, one of which communicates again with the second trunk of the fifth before its termination; the ganglion then sends another branch forward to form another glanglionic union with a branch of the second trunk of the fifth, and from this a branch is sent to the posterior part of the nose to ramify on the Schneiderian membrane; other branches are given to the membrane covering the mouth and palate, and one passes forward and communicates again with a branch of the second trunk of the fifth, and is distributed on the membrane covering the anterior part of the mouth and palate. It is worthy of remark, that the nerves distributed on the membrane of the mouth, palate, and nose, communicate so many times with branches of the second trunk of the fifth, and their connexion is so much greater than in the turtle; but in this creature the palate is horny, and not so extensive in proportion to the size of the head.

3. Prolongation of the sympathetic connected with the trunk of the par vagum, but not directly with the ganglion of the sympathetic; it communicates with the ninth nerve, then passes down the spine, and communicates with the eleven superior spinal nerves; it emerges on each side at the place the superior branches of the vertebral artery enter to distribute branches in the intercostal spaces; it is

continued downwards in a very fine plexiform prolongation with the vertebral artery, as far as the origin from the right aorta; it then branches to each side beneath the membrane connecting the viscera with the ribs and spine, and communicates with filaments of the par vagum; it is afterwards continued downwards, receiving a filament from each spinal nerve; in its course it is a very fine nerve, and has not any more ganglia than the first, and those communicating with the second trunk of the fifth, but, at different points from which the nerves pass to the viscera, there is an appearance of a delicate plexus: this plexiform structure varies in different parts, and becomes much greater about the beginning of the intestine, where it resembles that corresponding with the semilunar ganglion in the turtle; near the kidney it assumes the form of a nervous membrane or retina before it is distributed on the urinary and generative organs. Branches pass from the plexuses with the arteries to the different viscera.

4. Second trunk of the fifth; after communicating with the sympathetic, and giving filaments to the membrane of the mouth, palate, and nose, it passes out of its canal in the upper jaw, and terminates in branches on the upper lip.

5. Third trunk of the fifth; it gives branches to the muscles of the jaws, the greatest portion of it then passes within a canal in the lower jaw; it sends three branches through the opening at the inferior margin of this part, two of them to communicate with the branches of the par vagum and ninth distributed on the muscles and parts underneath the jaw; the other to give filaments to the membrane of the mouth as far as the sheath of the tongue; the trunk is continued onwards through the foramen near the chin to divide into branches and terminate on the lower lip.

6. Hard portion of the seventh; it communicates with the ganglion of the sympathetic, and then passes through the digastric muscle, to which it gives a branch; it communicates with the first spinal nerve, and terminates on the costa-maxillary muscle.

7. Glosso-pharyngeal nerve; it passes to the ganglion of the sympathetic.

8. Trunk of the par vagum; it communicates with the sympathetic, and then with a branch that appears to be the continuation of the glosso-pharyngeal from the ganglion of the sympathetic; it sends a branch to communicate with the ninth to pass to the muscles, &c., of the fauces; and is then continued downwards close to the trachea in company with each jugular vein; on the left side it also accompanies the carotid artery, and from this a small vessel also ascends with the right

trunk; it sends filaments on the large vessels towards the heart, and others behind each aorta similar to the recurrent nerves, to be distributed on the trachea and œsophagus; each trunk, for a short space, accompanies its corresponding pulmonary artery: a little above the liver it passes in front of the superior part of the lungs, and proceeds a short distance, where it is joined by its fellow to form a single nerve; this is continued downwards under a thick membrane on the liver, and appears to give filaments to this viscus, the lungs, and œsophagus; about the termination of the liver it sends a large branch, which has communicated freely with branches of the sympathetic to the left surface of the stomach, this gives filaments to the lowest part of the lungs, and terminates on the stomach. The right division, or the continuation of the nerve itself, having communicated several times with the left division and filaments from the plexus of the sympathetic, is continued a short way on the membrane connecting the viscera, it passes on the right surface of the stomach, distributing branches to this viscus, and terminates on the beginning of the intestine, reaching as far as the pancreas.

9. A nerve from the ganglion of the sympathetic; it appears to be the continuation of the glosso-pharyngeal after its junction with the ganglion; it communicates with the ninth after its connexion with a branch of the trunk of the par vagum, and terminates on the glottis and muscles attached to the anterior point of the jaw for drawing forward the trachea.

10. Ninth nerve; it receives a branch from the trunk of the par vagum, and from the hard portion of the seventh, after this has communicated with the first cervical nerve; it gives off several branches to the muscles of the tongue and throat, and one that reaches to the end of the tongue, and one to communicate with branches of the third trunk of the fifth, issuing out of the inferior part of the lower jaw. The glosso-pharyngeal, the trunk of the par vagum and the ninth, are so connected together that it is difficult to determine precisely to which nerve each branch belongs; they have been with great care apportioned to their respective nerves in this description; their final distribution will be seen in Plate XX.

11. First cervical nerve; it communicates with the hard portion of the seventh and the ninth, and then passes towards the angle of the jaw, distributing branches to the thin muscle, the costa-maxillary, and the continuation of this over the throat, which resembles the constrictor muscle in the turtle and the cutaneous in man.

PLATE XIX

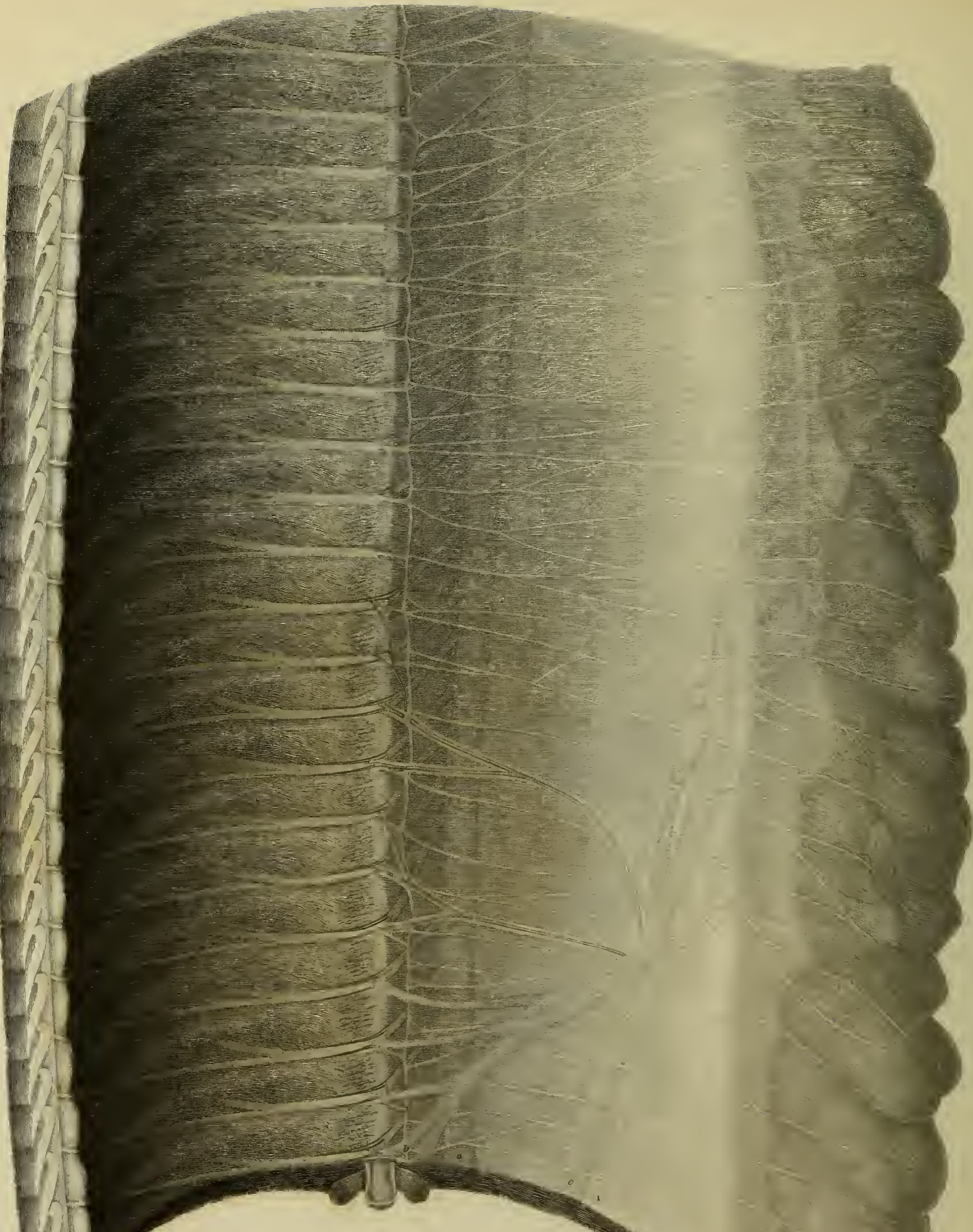

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PLATE XIX.

THE SYMPATHETIC NERVE OF THE SNAKE.

(BOA CONSTRICTOR.)

This view is taken from about the middle of the body of the same snake as in the preceding plate. The sympathetic is seen communicating with each spinal nerve, and then sending filaments on the membrane connecting the viscera with the spine and ribs, some of which are distributed on it, and continued as far as the fat contained in its anterior folds, whilst others pass to the viscera, blood vessels, &c.

a. Aorta.

b. Vein receiving blood from the intercostal spaces.

c. Gall duct.

1. Right division of the par vagum a little before its termination on the stomach.

2. Sympathetic nerve.

Without previous preparation, it is impossible to observe the extreme complexity, delicacy, and extent of the branches of the sympathetic in the snake. They present one of the most wonderful displays of minute structure that can be observed. In the recent state of the animal, the nerves from just below the head are so transparent, as to be with great difficulty distinguished from the surrounding parts; but after the animal has been opened through its whole length, and the connecting membrane of the viscera separated to a little distance from the margin of the ribs; after it has been immersed in water for a few hours, and then in spirits, or a solution of oxymuriate of mercury for a few days, and has had the membrane carefully detached nearly as far as the spine, the fie branches proceeding from the spinal nerves may be seen passing upon this membrane to a chord in some parts, and in others to a complicated plexus, varying in different parts according to a prescribed law, but observing a similar disposition to corresponding but varied distributions in other orders. So long, however, as it preserves the form of a chord, although it has communicated with a great number of spinal nerves, it does not acquire an increased size.

The brain of amphibia differs from that of fishes externally, in the size and shape of several parts. In the larger size of the anterior lobes, in which there is a capacious ventricle, a prominence in this that may be compared with the striated body and a choroid plexus, in not having any mammillary eminences. In having small thalami, connected together in the turtle by a very tenacious commissure, but not placed as in mammalia with respect to the lateral ventricles, but behind these and out of the cavities, and their situation is even more remarkable in the frog. In having posterior as well as anterior commissures, the anterior alone existing in some fishes. The ventricle in the optic lobe is very similar; but in the floor of this, the longitudinal bands extending towards the calamus scriptorius are more prominent. It differs in the very dense membrane covering it, especially in the turtle, in not having so much space in the skull, and not being placed in a fine reticulated membrane containing fluid. In having a pineal gland as well as pituitary one.

The cerebellum of the turtle differs from that of fishes in its smoothness and roundness, in not having lobes or an appearance of convolutions, as in the skate; in the thinness of its parietes, and the greater capacity of the ventricle.

In the snake, the brain is nearly the same as in the turtle; and there is not much difference in the frog, except that the thalami appear externally. In the snake and frog the cerebellum is so small, as hardly to bear a comparison with that of the turtle or fishes.

The brain of amphibia, compared with that of fishes, is rather more complicated, but still has very little development of parts ministering to the general functions of the body; the principal portions are larger or smaller, according to the required extent of the senses and the power of intellect. In both these classes the oblong medulla bears a greater proportion to the size of the brain than in the higher, and seems to be equally connected with the animal functions, and the lobes of the brain, as in them, to be superadded. The large size of the spinal marrow, as compared with that of the brain, is also very remarkable. When, therefore, the vast intricacy and number of the organs of the body in both these classes is considered, and that they are nearly as great as in the two higher classes, and when it is observed how small the size of the brain is in proportion to the nerves, it must be concluded that both the oblong and spinal medulla have peculiar and important functions; as the nerves bear no proportion to the size of the brain, but only to that of the oblong and spinal medulla, it must also be concluded that their power is principally derived from these parts. Appropriate functions are, however, performed by the nerves and their ganglia, and it may be presumed that some power is inherent in them, for there is very little else belonging to the nervous system of many invertebrated animals.

The power of the nervous system is, in many respects, increased or diminished according to the quantity of nervous matter forming the centres, and the supply and quality of the circulating fluids. When the blood is less perfectly changed by respiration, the brain is less, as in fishes and amphibia; the spinal marrow, however, is not less, but is proportionate to the requisite quantity of nerves for the supply of the body, as in birds and mammalia. The more extensive change of fluids, as in these higher classes, is not therefore necessary for the preservation of the nervous matter; but a greater bulk of brain under this imperfect oxygenisation of the blood, as in fishes and amphibia, is not generally consistent with the free and healthy functions of the various organs of the body, and even with the maintenance of life. The structure of the brain and spinal marrow of fishes and amphibia is somewhat different from that of birds and mammalia; but they can display great muscular power in the same manner, although it is doubtful whether they can maintain it for the same time.

When the circulation is more languid, the animals exposed to low temperatures, and the motions of the tail not very great in individual parts, it appears that the continuation of the spinal marrow is preferred to the usual cauda equina of mammalia; and it is very probable that the power of the nerves is thus less easily intercepted, and the functions of the parts, under all circumstances, are more certainly preserved. But even in the higher classes, and particularly in birds, when the spinal marrow can be conveniently accommodated, it may with greater security allow of the distribution of the numerous small nerves issuing from it.

In amphibia the nerves are firmer than in fishes, and acquire much magnitude from the addition of neurilema. In the snake, those about the throat are not only tortuous, but in a considerable degree elastic, and thus allow of being sufficiently extended in deglutition. They are large in comparison with the whole brain, but accord with the size of the oblong and spinal medulla, as in fishes. In the turtle and snake, the olfactory nerves have not distinct ganglia: after being joined by the first trunk of the fifth, they are distributed in coarse branches on the Schneiderian membrane, and appear similar, although the turtle feeds on vegetable, and the snake on animal substances; but it may be remarked, that their structure corresponds very much with that of the splanchnic plexuses, which have not ganglia intermixed with, or giving immediate origin to them. The origin of the optic nerves is from the optic lobes and thalami, and not from the optic lobes and mammillary eminences, as in fishes. In the other nerves of the orbit there is not any particular change, except that the sixth is larger, and supplies the additional muscles, which do not exist in fishes; and in the turtle the ciliary nerves proceed from a junction of branches from the third and fifth nerves, but this has not the form of a ganglion. The fifth has not a very distinct smaller portion for joining the third trunk, but there is a greater resemblance to the form of the Gasserian ganglion than in fishes; the usual cutaneous branches pass through perforations in the bone to the parts beneath the horny covering in the turtle, but this disposition does not exist in the same degree in the snake, and is therefore a peculiarity for corresponding with the conformation of the parts receiving them. The par vagum and glosso-pharyngeal at their origins are not very different from the same in fishes, except that they are not so much connected with the auditory nerve; but even in the turtle and snake there are differences which may be best judged of by a reference to the plates. In the snake so many communications between the glosso-pharyngeal, par vagum, and ninth, take place before branches are given off to supply any parts, that it is very difficult to determine with precision the destination of each, for the muscles and other structures of the throat are so complicated, and at the same time so connected in function, that although the nerves be different at their origins, yet it seems they must be connected for associating the actions of the parts receiving them. In amphibia the par vagum appears to supply almost entirely the heart. When the slight difference between the summit and base of the brain in the turtle and skate is considered, it cannot fail of being remarked that so many more nerves exist in the turtle than in the skate, as the hard portion of the seventh, a more distinct auditory nerve, the ninth and accessory; the brain of the skate is, however, more simple in some respects, and several parts of the body are different from the turtle.

In the sympathetic nerve there are several varieties in different genera of amphibia. In the turtle and snake, there is not a canal in which the sympathetic passes with a vertebral artery; the branch, according with the one ascending from the first thoracic ganglion in mammalia, passes on the outside of the spine in the turtle, and in the snake, in an incomplete canal near the connexion of the ribs with the eleven superior vertebræ. In the turtle, there is a prolongation, but no cervicalganglia; it is more or less closely attached to the par vagum, but does not exist in the snake, or, if it does, its small size prevents its being easily recognised and distinctly separated. The sympathetic does not appear to be more highly evolved than in fishes; for in the turtle, the ganglia attached to the prolongation are very diminutive, except the first thoracic, which is broad, and has a membranous character; and in the snake, except at its superior part, where there is one remarkable ganglion connected with the trunk of the par vagum, and several smaller ones at the junction of the sympathetic with branches of the second trunk of the fifth proceeding to the palate and nose; in the snake for some distance there are very slight plexiform junctions of the branches from the spinal nerves which join the prolongation; but these plexuses are in some parts more complicated, and in both the snake and turtle exist for giving off the nerves to the viscera instead of the close and fleshy semilunar ganglia. In the frog as in the snake, except the first cervical, no other distinct ganglia of the sympathetic exist, and the branches destined for the abdominal viscera also join a prolongation from which the splanchnic branches are derived.

The spinal nerves of the snake are not very different from those of fishes, except in the closeness of their origins, and the more regular communications of the anterior and posterior bundles of each nerve, and having more distinct and fleshy ganglia. In the frog there is one large nerve instead of a number forming the axillary plexus, as in the turtle; in both however there is a plexus resembling that in the higher classes for giving off the nerves of the posterior extremities, and the spinal nerves, entering it, correspond with these, inasmuch as they have their origin from the inferior part of the spinal chord, just above that from which the caudal nerves usually issue.

The whole of these observations, relating to the anatomy of the nervous system of amphibious animals, have been derived from dissections of the snake, the frog, and two species of turtle.

Fig. 1.

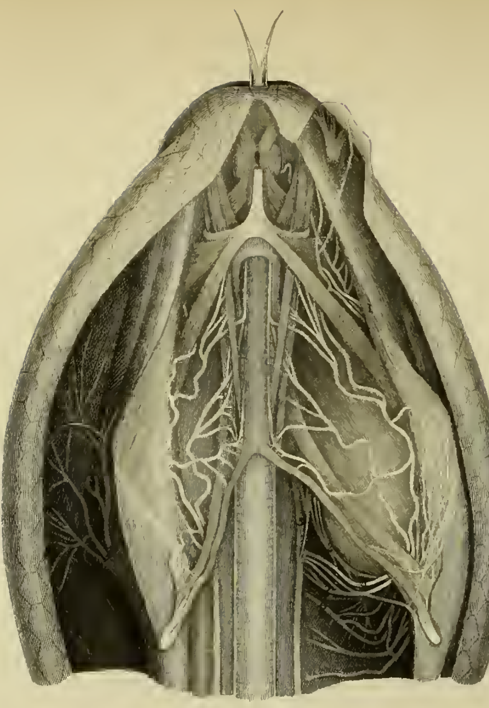

Fig. 2.

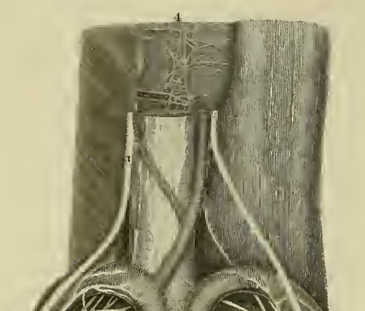

Fig. 3.

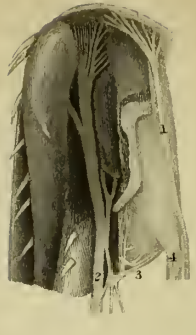

Fig. 4.

Fig. 5.

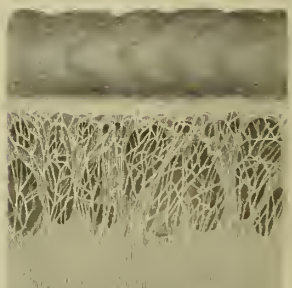

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PLATE XX.

THE SNAKE.

(BOA CONSTRICTOR.)

FIGURE I.

THE parts on the right side have been drawn outwards, to allow room for showing the nerves.

1. Three branches of the third trunk of the fifth issuing from the lower jaw; two of them communicate with the ninth, as in *5*; the other gives branches to the membrane of the mouth as far as the sheath of the tongue.

2. Hard portion of the seventh.

3. Trunk of the par vagum.

4. A nerve corresponding with that in 9, Fig. 2, Plate XVIII., derived from the ganglion of the sympathetic, and appearing to be the continuation of the glosso-pharyngeal nerve: it terminates on the glottis and the muscles attached to the anterior part of the jaw for drawing forward the trachea.

5. Ninth nerve, joined by a branch from the trunk of the par vagum; it gives branches to the muscles of the tongue and fauces, one of which becomes imbedded in the hyo-glossal muscle, and receives communicating branches from the same nerve in its course to the tip of the tongue; it communicates with two of the branches of the third trunk of the fifth issuing from the inferior part of the lower jaw, to be distributed a little more forward on the membrane and skin covering this part.

6. First cervical nerve.

7. Branches of cervical nerves given to the integuments.

FIGURE II.

(THE SAME.)

1. Trunk of the par vagum.

2. Recurrent nerves, which are very small; a great portion of the trachea receiving filaments from the trunk of the par vagum.

3. Trunk of the par vagum passing downwards to be united with its fellow; but the union takes place lower than is here represented.

4. Continuation of the sympathetic in the form of a plexus near the vertebral artery; in the neck, for some distance, it appears to join branches of the spinal nerves issuing from between the attachments of the muscles on the anterior part of the spine, near to the extremities of the ribs, to be distributed on the œsophagus.

FIGURE III.

(THE SAME.)

1. Continuation of the first trunk of the fifth, as in 5, Fig. 1, Plate XVIII., to terminate on the skin at the end of the nose; before leaving the orbit, it also gives off a ciliary branch, and one to the skin above the upper eyelid.

2. Second trunk of the fifth, terminating on the upper lip.

3. A branch from the palatine ganglion, described in 2, Fig. 2, Plate XVIII., from a union of a branch of the sympathetic with one from the second trunk of the fifth, passing to the membrane covering the septum of the nose.

4. Olfactory nerve.

FIGURE IV.

(THE SAME.)

The sympathetic nerve near the beginning of the intestine is shown, taking a different disposition from that in the part higher up, which has been exhibited in Plate XIX.; it accords in a considerable degree with the plexus of the turtle, which is in the place of the semilunar ganglion, and gives off numerous nerves to the intestines.

FIGURE V.

(THE SAME.)

This shows the sympathetic lower down than the preceding figure; it forms a plexus resembling a retina, from which branches are sent to the ovary, the oviducts, and kidney. The distribution is the same in the male, except that the branches terminate on the testis and vas deferens, instead of the ovary and its duct.

In the crocodile, the sympathetic nerve is continued down the neck, in a canal like that of the vertebral artery in birds, and then underneath a process from the head of each of the three superior ribs: it is continued in the thorax double from one ganglion to another. The branches of the sympathetic form a plexus instead of a semilunar ganglion, from which branches proceed to the stomach, the liver, and intestines. Branches then pass to the ovary and kidney, and appear to have a disposition between that in the turtle and snake; the sympathetic passes down, and forms a junction with that of the opposite side on the caudal artery, along which it is continued into the tail, nearly as in the calf. The ganglia throughout the sympathetic were not distinct. The spinal marrow reached to the tail, and each posterior trunk formed a ganglion. The nervous system was almost entirely covered by a black membrane. The subject from which this description was made did not allow of a particular examination of the origin of the sympathetic, nor of its connexion with the par vagum at the anterior part of the neck.

Fig. 1.

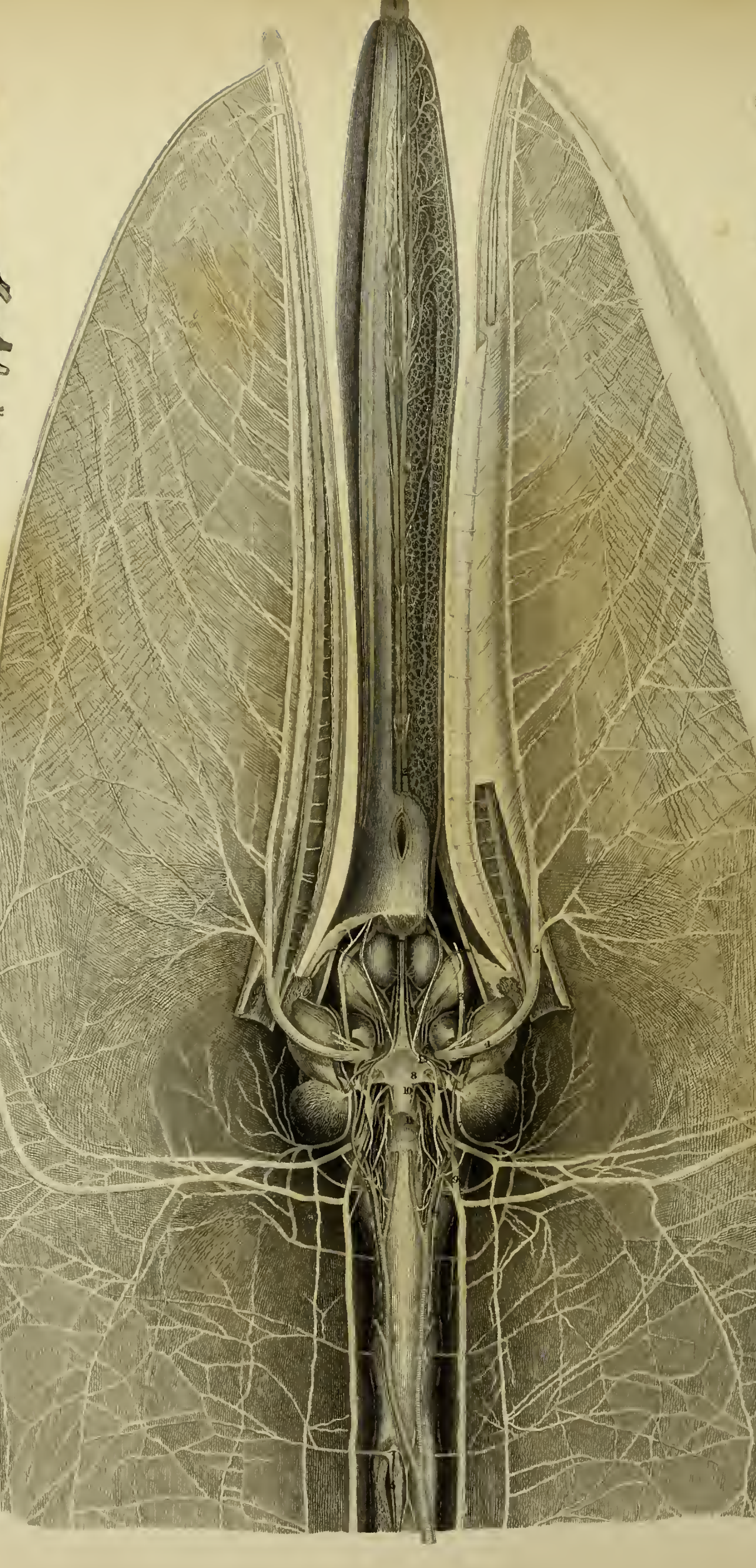

Fig. 2.

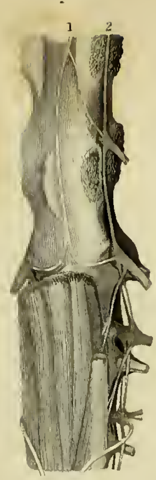

Fig. 3.

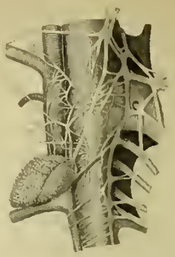

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PLATE XXI.

THE PELICAN.

(PELECANUS ONOCROTALUS.)

FIGURE I.

In making the preparation from which this plate was taken, the skin, the œsophagus, the pharynx, and lower jaw, were divided in the median line, and turned outwards; the lining membrane of the œsophagus and pharynx was carefully separated, and the nerves partially traced, portions of the lower jaw and of the upper were then removed, for showing their continuations. In all similar subjects where the parts are very thin, after a slight separation of some of them, the subject should be immersed in water for a few hours, and afterwards kept in very weak spirits during the progress of the dissection, for if it should be at first placed in alcohol, the nerves and membranes become so impacted on each other, and so soon dry on exposure to the air, as to make the dissection very unsatisfactory.

1. Third nerve.

2. First trunk of the fifth, sending off branches to the palatine or inferior surface of the upper jaw, and at a short distance from the beak giving off a large branch to distribute filaments on the superior surface of the anterior portion of the upper jaw, some of which communicate with others from the second trunk.

3. Second trunk of the fifth, giving a large branch to the upper eyelid, and branches to the palate, then passing at the exterior margin of the upper jaw, and giving off numerous filaments to the superior surface of this part.

4. Third trunk of the fifth, giving branches to the muscles of the jaw, and sending

off the large branch, 5; it then passes within the jaw, distributing filaments through perforations to terminate on the membrane covering the exterior of this part; at some distance from the beak it gives off a very large branch, which is still continued within the jaw, but near the beak it passes through a foramen, and divides into two branches to terminate on the mylo-hyoideal muscle.

5. Large branch of the third trunk of the fifth, giving off numerous branches, which divide into two planes, one to terminate on the mylo-hyoideal muscle and the membrane lining the fauces, the other on this muscle and the skin.

6. Sixth nerve, giving a branch to the abducent muscle and that of the nictitating membrane.

7. Hard portion of the seventh; it gives a branch to the digastric muscle, and then becomes connected with several cervical nerves, which terminate on the skin and cutaneous muscle, and communicate with branches of the conjoined glosso-pharyngeal, par vagum, and ninth.

8. Glosso-pharyngeal nerve, on which the ganglion of the sympathetic is situated: it becomes united with the trunk of the par vagum, and then divides into numerous branches for the muscles of the fauces, the pharynx, and trachea, a larger one accompanying the long muscle, resembling the genio-hyoideal or hyo-glossal, as far as the beak; many filaments communicate with branches of the conjoined hard portion of the seventh and spinal nerves.

9. Trunk of the par vagum; it becomes united with the glosso-pharyngeal and ninth, and sends off a large branch to join the one proceeding from its previous union with the glosso-pharyngeal; it sends off another large branch to join this union; it then receives a branch of the second cervical nerve, passes down the neck, and gives the recurrent branches to the larynx and œsophagus, also branches to join the cardiac branches of the sympathetic for the heart; it gives branches to the lungs, and then descends to terminate on the stomach, as in the crane.

10. Ninth nerve, uniting with the trunk of the par vagum.

11. Second cervical nerve, giving off a branch to join the trunk of the par vagum, and branches to the cervical muscles, and then passing outwards to join branches of the hard portion descending to the second cervical nerve, and from this to the next, &c., to terminate on the cutaneous muscle and skin.

12. Superior branch of the sympathetic nerve, communicating with the hard portion of the seventh, and then joining the second trunk of the fifth, close to its connexion with the third trunk.

13. Inferior branch of the sympathetic; it sends a branch to the palate, and one to join the branch of the third nerve, passing to the inferior oblique muscle of the eye; it gives filaments to Harder's gland, and there joins the first trunk of the fifth. The nerve from which this and the superior branch proceed appears like the trunk of the glosso-pharyngeal.

14. A branch of the sympathetic nerve, proceeding from the inferior part of the ganglion to accompany the carotid artery to the bifurcation, where it joins that of the other side; it gives off filaments to branches of the artery, and to communicate with the prolongation of the sympathetic accompanying the vertebral artery, at the bottom of the neck it dips down between the anterior cervical muscles, and divides into two branches to join the last cervical ganglion but one on each side.

15. Prolongation of the sympathetic, accompanying the vertebral artery, and communicating with each cervical nerve.

FIGURE II.

(THE SAME.)

1. Continuation of the sympathetic, accompanying the carotid artery, and dividing into two branches to join the last cervical ganglion but one on each side.

2. Continuation of the sympathetic accompanying the left vertebral artery; one filament connecting it with the branch accompanying the carotid artery has been preserved.

FIGURE III.

(THE SAME.)

This shows the connexion between the inferior splanchnic plexus of the sympathetic and the renal capsule, and between this and the ovary.

PLATE XXII.

Fig. 1.

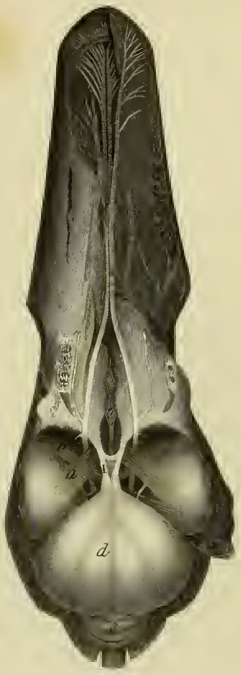

Fig. 2.

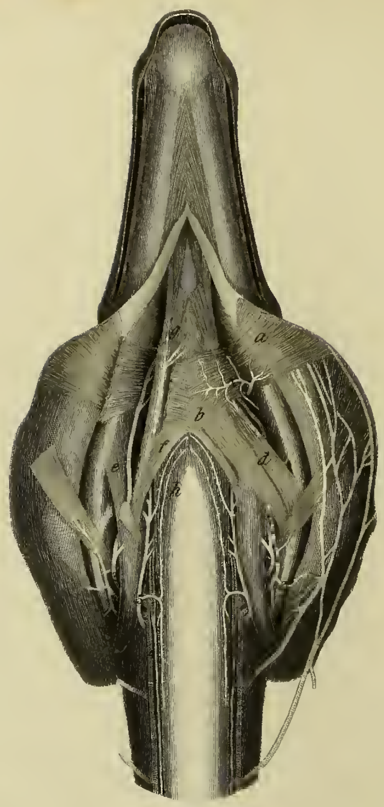

Fig. 3.

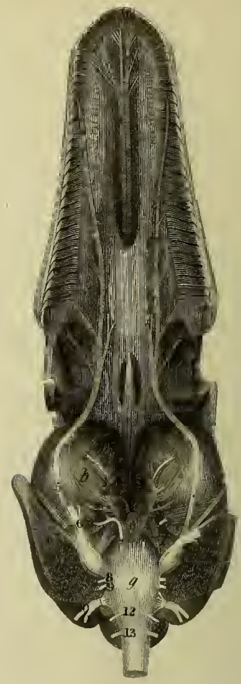

Fig. 7.

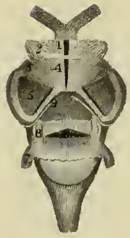

Fig. 5.

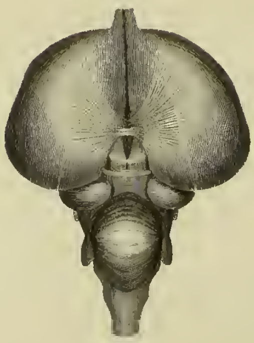

Fig. 6.

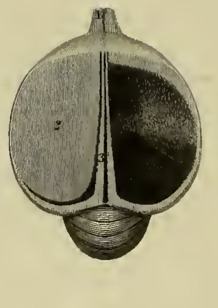

Fig. 8.

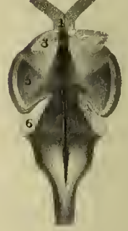

Fig. 9.

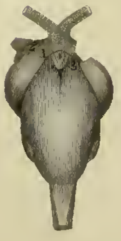

Fig. 4.

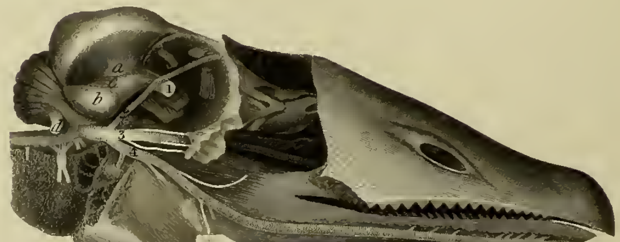

Fig. 10.

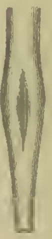

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PLATE XXII.

THE GOOSE.

(ANSER PALUSTRIS.)

FIGURE I.

a. Superior oblique muscle of the eye.

b. Adductor muscle.

c. Attollent muscle.

d. Brain.

e. Cerebellum.

1. Olfactory nerve, spreading round the superior part of the Schneiderian membrane, and thus forming an appearance of a hollow ganglion.

2. Pathetic nerve to the superior oblique muscle.

3. First trunk of the fifth; it passes close to the olfactory nerve, and appears to be connected with this, and gives filaments to the Schneiderian membrane; it meets its fellow on the floor of the nose, and then gives off a large branch to the exterior of the upper jaw near the beak, and another to divide on the palate, and send branches through perforations in the bone to the membrane covering the beak.

4. Second trunk of the fifth, giving branches to the posterior part of the beak and palate.

FIGURE II.

(THE SAME.)

In the goose all the muscles concerned in the motion of the jaws for mastication, as well as the delicate mylo-hyoideal, and a thin square muscle arising from the side of the lower jaw, and inserted into the hyoid bone, are supplied by the fifth ; and for this reason the latter muscle ought to be compared with the maxillary portion of the digastric in man. A muscle arising from the head and inserted into the angle of the jaw, and compared with the upper belly of the digastric, and another analogous to the stylo-hyoideal, arising from the lower jaw, and inserted into the side of the hyoid bone, are supplied by the hard portion of the seventh, which also communicates with the cervical nerves given to the cutaneous muscle of the face and neck. The long muscle on the side of the trachea, the hyo-laryngeal, the trachea, the hyo-glossal, and lingual, are supplied by the ninth ; another muscle arising from the lower jaw, and connected with the posterior part of the hyoid bone, is supplied by the glosso-pharyngeal, whilst the rest of this nerve terminates on the surface of the tongue, reaching as far as the tip. The following muscles have been denominated according to the supply of corresponding nerves in mammalia.

a. Mylo-hyoideal muscle.

b. Maxillary portion of the digastric muscle.

c. Superior portion of the digastric muscle.

d. A muscle that may be compared with the stylo-hyoideal.

e. Cerato-maxillary muscle, arising from the lower jaw, and then surrounding the cornu of the hyoid bone.

f. Hyo-glossal muscle.

g. Lingual muscles.

h. Hyo-laryngeal, or tracheal muscle.

1. Branch of the third trunk of the fifth to the mylo-hyoideal muscle, and another muscle, arising from the side of the lower jaw, and inserted into the hyoid bone; this muscle is analogous to the maxillary portion of the digastric.

2. Hard portion of the seventh ; it communicates with the sympathetic, and sends branches to muscles analogous to the superior belly of the digastric and the stylo-hyoideal, and communicates with a branch of the second cervical nerve, to terminate on a cutaneous muscle connected with the external auditory meatus and the posterior

part of the face, and upper part of the neck; after having communicated with the second cervical nerve, it appears to pass down and communicate with the third, and then with the fourth; and although the fourth communicates with the fifth, this with the next, and so on, it cannot be determined that it is through the continuation of the hard portion of the seventh.

3. Glosso-pharyngeal nerve; it gives a branch to the pharynx and œsophagus, and muscles connected with the glottis, and then passes near the lower jaw to the hyoid bone, gives a branch to the cerato-maxillary muscle, arising from the lower jaw and surrounding the posterior part of the hyoid bone, and then passes on the surface of the tongue, distributing filaments as far as the tip, and communicating with branches of the nerve of the opposite side.

4. Trunk of the par vagum.

5. Ninth nerve; it gives a branch to the hyo-laryngeal muscle, placed at the side of the trachea, and sends a large branch forward to give a branch to the hyo-glossal and lingual muscles.

6. Second cervical nerve, communicating with the hard portion of the seventh, and distributed on the cutaneous muscle and skin of the face.

FIGURE III.

(THE SAME.)

a. Inferior oblique muscle of the eye.
b. Depressor.
c. Adductor.
d. Muscle of the nictitating membrane.
e. Abductor.
f. Optic lobes.
g. Oblong medulla.
h. Cerebellum.
1. Optic nerve.
2. Third nerve, giving branches to the inferior oblique muscle, the adductor, levator, and depressor.

3. A branch of the third nerve, receiving a filament from the first trunk of the fifth to form the ciliary nerve.

4. First trunk of the fifth continued to the palate; it passes through the orbit, and appears to be connected with the olfactory nerve at the nose; it gives filaments to the Schneiderian membrane, and then meets its fellow close on the floor of the nose, and divides to distribute many filaments on the palate, and send some through perforations in the bone to the covering of the beak.

5. Second trunk of the fifth, given to the posterior part of the beak and palate.

6. Third trunk of the fifth cut short; a part having a separate origin from that of the ganglion, somewhat similar to the muscular portion of mammalia, is seen passing to it; it gives branches to various muscles of the jaws connected with the omoid and square bones, and then enters a canal in the jaw, and sends filaments through perforations in the jaw to the masseter and other muscles, and to the teeth and membranous covering of the lower jaw, and particularly the beak.

7. Sixth nerve, given to the abductor muscle of the eye, and the muscles of the nictitating membrane.

8. Hard portion of the seventh; it enters a foramen anteriorly to the auditory nerve; it passes downwards and backwards on the outer side of the vestibule, and escapes at a foramen in the posterior part of the external auditory meatus, after having communicated with the sympathetic nerve.

9. Auditory nerve.

10. Glosso-pharyngeal nerve.

11. Trunk of the par vagum.

12. Ninth nerve.

13. First cervical nerve.

FIGURE IV.

(THE SAME.)

a. Crus of the brain, proceeding from the anterior lobe, part of which has been removed.

b. Optic lobe, continued to the optic commissure.

c. A process from the thalamus to the optic commissure.

d. Lateral lobe of the cerebellum.

1. Optic nerve.
2. First trunk of the fifth.
3. Second trunk of the fifth.
4. Third trunk of the fifth.

FIGURE V.

(THE SAME.)

A separation has been made at the median line of the hemispheres of the brain for showing the radiated septum.

FIGURE VI.

(THE SAME.)

On cutting off a small portion of the summit of the brain on each side near the median line, a narrow ventricle, deep at the internal part, extends nearly to the base of the hemisphere; over the third ventricle the partition between the two lateral ventricles is composed of two layers of radiated medullary fibres, and is very similar in form to the septum lucidum, and at its posterior or broader part diverges from the middle line, and leaves a triangular space. The posterior wall, which is a continuation of the septum, is very thin, and is extended over the third ventricle like the former; pillars from the anterior part pass down, and are inserted into, or joined with, the crura of the brain. The part of the hemisphere projecting into this cavity, is termed the striated body. At the anterior part there are two chords proceeding from the hemispheres, and passing just above the optic tracts, which are the crura of the brain. Beneath the lateral ventricles there is a substance on each side connected by a commissure, and these appear to be the thalami, between which the third ventricle is situated. The third ventricle communicates with a cavity in each of the optic lobes, and then passes under the cerebellum to the calamus scriptorius. It appears as if the optic lobes and thalami existed, but are more confounded with each other than in mammalia, and thus a different conformation of parts is produced.

1. Olfactory nerve.
2. Striated body.
3. Radiated septum, forming the middle boundary of the lateral ventricle.
4. Lateral ventricle; the anterior part is rough, from which much of the striated body has been removed.

FIGURE VII.

(THE SAME.)

1. Anterior pedicles of the radiated lamina.
2. Crus of the brain.
3. Portion of the thalamus extending to the optic commissure.
4. Thalamus of the optic nerve.
5. Cavity of the optic lobe.
6. Ventricle in the cerebellum.
7. Lateral lobe of the cerebellum.
8. Crus of the cerebellum.
9. Fourth nerve.

FIGURE VIII.

(THE SAME.)

1. Optic tract connected with the thalami, optic lobes and crura of the brain.
2. Pedicles of the radiated lamina or septum of the lateral ventricles.
3. Crus of the brain; on the right side it has been more separated from the optic tract than on the left.
4. Third ventricle continued to the calamus scriptorius; its sides have been rather too much separated, and thus at the bottom the joining threads of the two sides have been exposed, and some of these have been delineated in the engraving.
5. Ventricle in the optic lobe.
6. Cut edge of the cerebellum.

FIGURE IX.

(THE SAME.)

1. Continuation of the optic lobe to the optic tract.

2. Continuation of the thalamus to the optic tract. The optic lobes and thalami are so connected as to make it difficult to define the limits of each, and the precise extent of the origin of the optic tract from each of these parts.

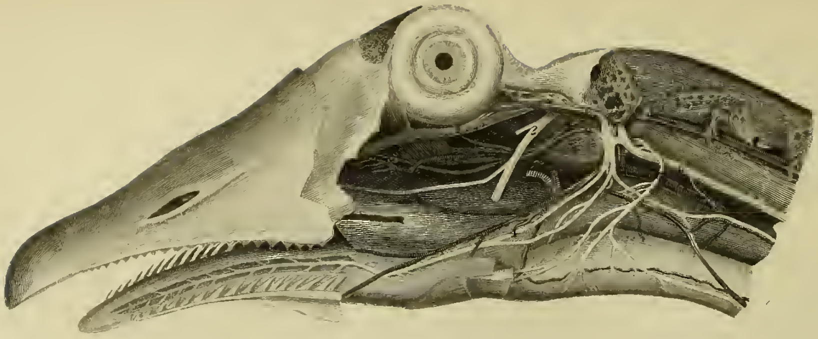
3. Continuation of the crus of the brain towards the oblong medulla; a portion of the optic tract has been removed for the purpose of showing it.

FIGURE X.

(THE SAME.)

This shows the lumbar ventricle of the spinal marrow.

Fig 1



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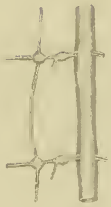

Fig. 5.

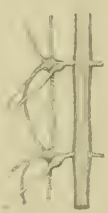

Fig. 6.

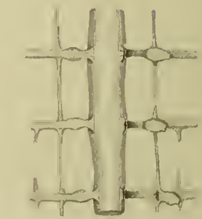

Fig. 2.

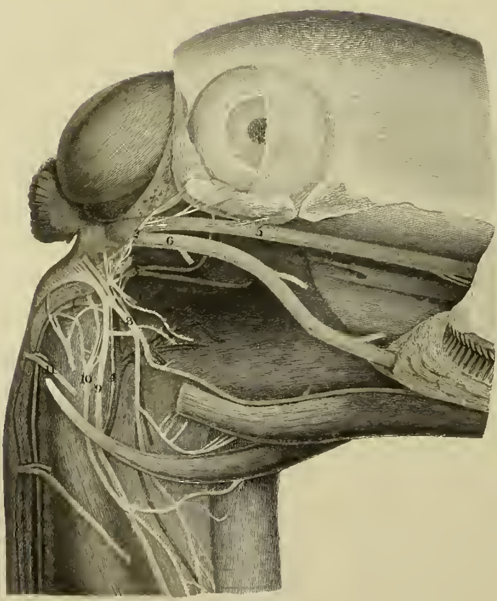

Fig. 3.

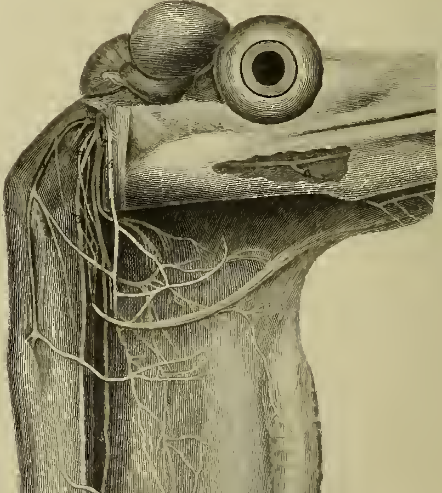

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PLATE XXIII.

THE SYMPATHETIC NERVE OF THE GOOSE.

(ANSER PALUSTRIS.)

FIGURE I.

1. SECOND trunk of the fifth nerve.

2. Third trunk of the fifth nerve.

3. A branch of the hard portion of the seventh passing to the superior branch of the superior ganglion of the sympathetic.

4. A branch of the glosso-pharyngeal nerve, which has supplied the cerato-maxillary muscle, and rejoined the continuation of the nerve, which supplies the surface of the tongue in its course, and towards the anterior part communicates freely with the nerve of the opposite side.

5. Trunk of the par vagum.

6. Ninth nerve.

7. Prolongation of the sympathetic nerve, accompanying the vertebral artery. It proceeds from the superior ganglion, which is placed between the glosso-pharyngeal nerve and the par vagum. Another branch passes down the neck with the carotid artery, and although it appears to be principally for supplying the blood-vessels, it corresponds with the prolongation on the anterior part of the neck in other classes.

8. Superior branch of the sympathetic passing from the superior ganglion; it accompanies a large artery to the orbit, and is continued forward to communicate with the second trunk of the fifth, and give filaments about the lachrymal gland.

In the pelican, the branch proceeding to the lachrymal gland appears to be derived rather from the second trunk of the fifth, after this has received the branch of the sympathetic.

9. Inferior branch from the superior ganglion of the sympathetic, passing at the base of the skull with the internal carotid artery; it receives a branch 3, from the hard portion of the seventh, and then goes forward, and sends one branch into the orbit to Harder's gland, and communicates with the first trunk of the fifth; it sends another to the posterior part of the palate and nose, and to communicate with the second trunk of the fifth.

FIGURE II.

THE SYMPATHETIC NERVE OF THE SWAN.

(CYGNUS OLOR.)

1. Prolongation of the sympathetic; after leaving the canal of the vertebral artery it communicates with the ninth, and then with the superior ganglion which lies between, and is connected with the trunk of the par vagum and the glosso-pharyngeal, at their exit from their osseous canals, and is placed partly upon the latter nerve.

2. Superior branch of the superior ganglion of the sympathetic; it passes with a large artery to the orbit, and communicates with the second and third trunks of the fifth, and with the hard portion of the seventh; it gives a branch to the lachrymal gland and conjunctive membrane; it sends one branch beneath the slender bone of the tympanum to join the inferior branch 3, close to the glosso-pharyngeal nerve.

3. Inferior branch of the superior ganglion of the sympathetic, passing with the internal carotid artery: it begins by a branch passing upwards from the glosso-pharyngeal nerve; it receives a branch from the superior branch 2, passing beneath the slender bone of the tympanum; it is continued onwards and receives a branch from the hard portion of the seventh; it then divides into two branches, one passes into the orbit to the gland of Harder, after sending a filament to the first trunk of the fifth, the other passes to the palate and nose.

4. Descending branch from the superior ganglion of the sympathetic accompanying the carotid artery to the bottom of the neck, and communicating several times with its fellow.

5. Second trunk of the fifth.

6. Third trunk of the fifth.

7. Hard portion of the seventh.

8. Glosso-pharyngeal nerve.

9. Trunk of the par vagum.

10. Ninth nerve.

11. Prolongation of the sympathetic, communicating with a spinal nerve; it passes down in a canal with the vertebral artery, and communicates with all the other cervical nerves. The posterior trunk, or division of each cervical nerve, is not joined to the sympathetic, but only the anterior; and on this, after it has left the spinal ganglion, the sympathetic ganglion is formed, from which a nerve passes, giving some filaments to the muscles on the anterior part of the neck, and then terminating on the skin. The posterior trunk or division terminates on the posterior part of the neck. The division into an anterior or posterior trunk is the same in the crane; the anterior communicating with the sympathetic, and being distributed in the same manner as in the swan, and the posterior trunk on the muscles and skin at the posterior part of the neck.

FIGURE III.

CONNEXIONS OF THE NERVES IN THE NECK OF THE CRANE.

(ARDEA CINEREA.)

1. Sympathetic nerve passing up in the canal with the vertebral artery.

2. Glosso-pharyngeal nerve: it soon becomes united with the ninth; branches are then given to the muscles and other parts, which receive them from similar, but separate nerves in the goose.

3. Trunk of the par vagum; it descends so close to the spinal nerves, that it is difficult to determine whether its adhesion to these be not through nervous matter; but after a careful examination, it appeared most probable that it was by mere expansions of neurilema.

4. Ninth nerve.

5. Hard portion of the seventh, giving a branch to the digastric muscle, and com-

municating with the second cervical nerve, the par vagum, and glosso-pharyngeal near the junction of this with the ninth, and sending a branch to terminate on a thin slip of muscle, that may be analogous with the stylo-hyoideal in the goose; after it has communicated with the second cervical nerve, it is connected also with the third, and several more in passing down the neck, but at length cannot be recognised; in this course it gives filaments to the long cutaneous muscle.

6. A branch of the third trunk of the fifth passing out of the jaw; it is similar to the small one in the goose 1, Fig. 2, Plate XXII., and the larger one in the pelican 5, Fig. 1, Plate XXI.

FIGURE IV.

THE GOOSE.

(ANSER PALUSTRIS.)

Part of the cervical portion of the sympathetic nerve is represented, showing a ganglion connected with the anterior trunk of each spinal nerve, and not with the posterior.

FIGURE V.

(THE SAME.)

This figure shows the thoracic portion of the sympathetic, and the connexion of its ganglia with those of the spinal nerves.

FIGURE VI.

(THE SAME.)

The sympathetic nerve is represented in connexion with nerves entering the axillary plexus, and as having an equal communication with the anterior and posterior bundles.

Fig. 1.

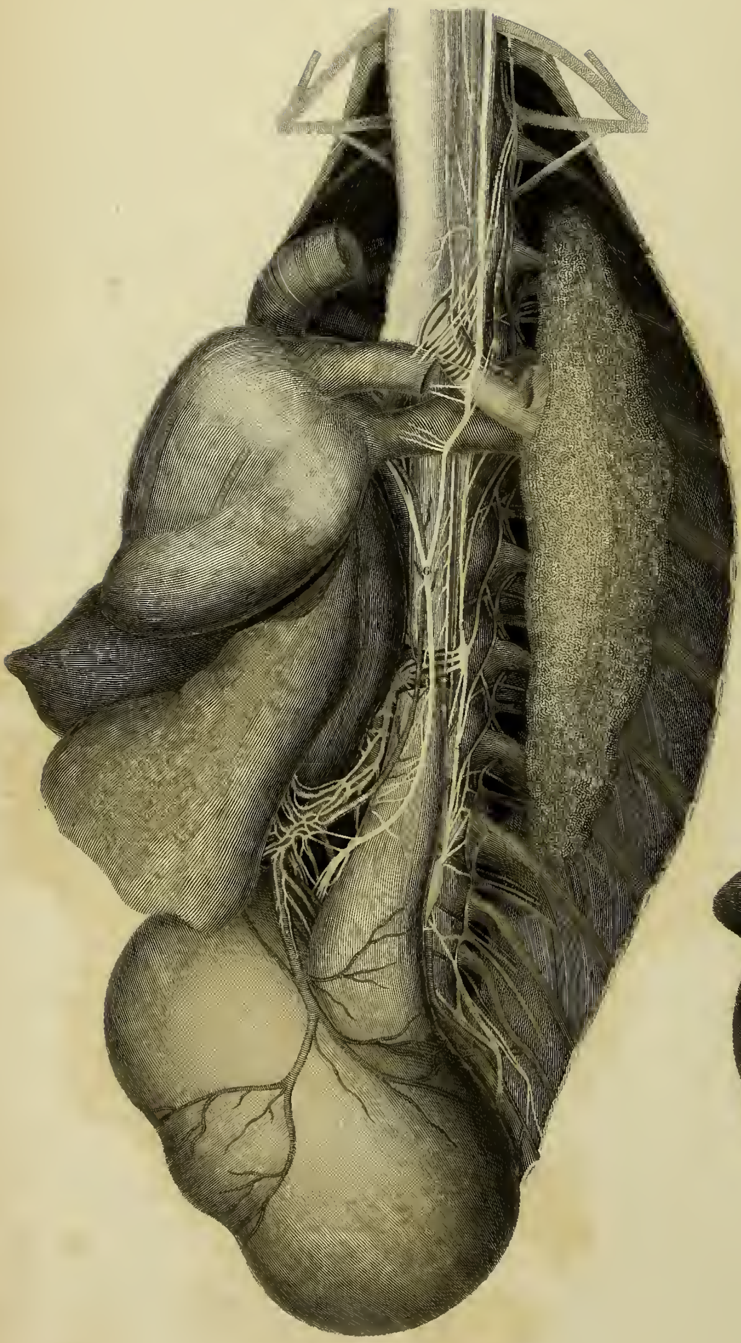

Fig. 2.

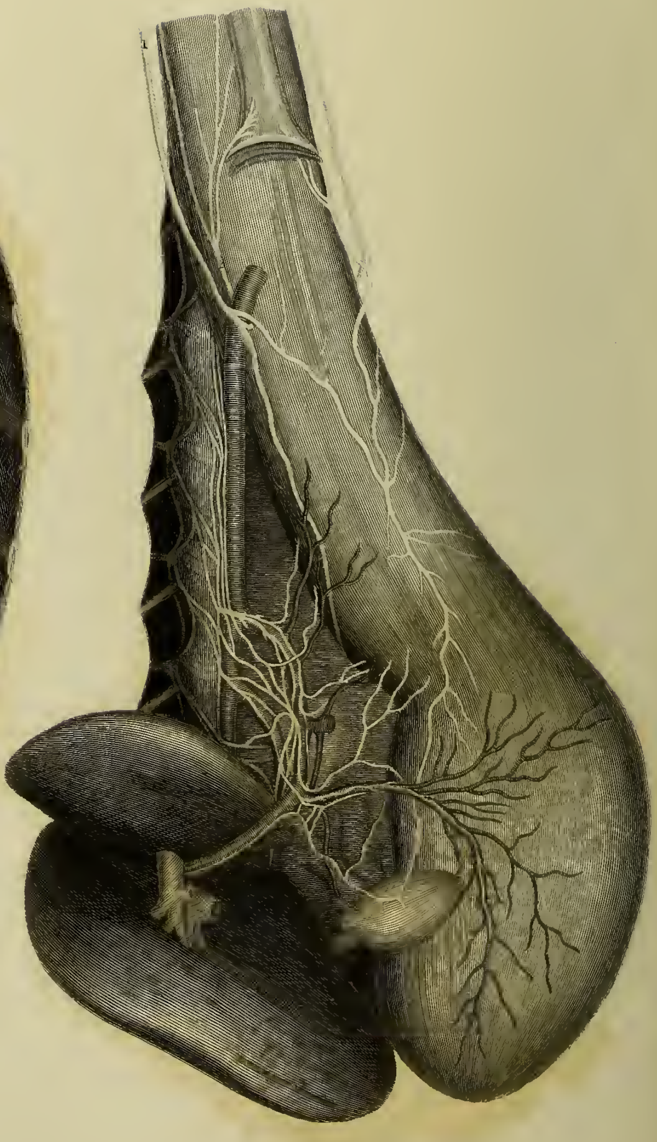

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PLATE XXIV.

THE THORACIC PORTION OF THE SYMPATHETIC NERVE IN THE LEFT SIDE OF THE SWAN.

(CYGNUS OLOR.)

FIGURE I.

1. SYMPATHETIC nerve: at the very bottom of the neck it emerges from the vertebral canal, and is continued through the thorax, and near its entrance into this begins to form a double communication with the spinal nerves, one branch passing over the other underneath the head of each rib. The ganglia are connected with the ganglia of the six dorsal nerves after the first, but with the cervical and lumbar nerves, and not the ganglia. On separating the anterior and posterior bundles of one of the largest spinal nerves, the sympathetic appeared to communicate quite as much with one as the other.

2. Branches from the first thoracic ganglion to communicate with the pulmonary branches of the par vagum, and accompany the large blood-vessels to the heart.

3. First large splanchnic nerve; it is given off by the thoracic portion of the sympathetic, and after communicating with that of the right side on the cœliac artery, the branches proceed from the union along the branches of this artery to the liver, the upper portion of the small intestines and the gizzard, and on this organ communications take place with branches of the par vagum.

4. Second large splanchnic nerve formed by branches from the prolongation and several thoracic ganglia, it corresponds more particularly with the splanchnic nerve of mammalia; it passes to the renal capsule, with which it becomes intimately united, and then distributes its branches to the small intestines, and the ovaries or testes.

5. Recurrent branch of the par vagum.

6. Union of each trunk of the par vagum passing to the gizzard. The par vagum, after having communicated with the sympathetic, the glosso-pharyngeal, and the ninth, passes down the neck, accompanied by the internal jugular vein: on the right side it extends over the arch of the aorta, and sends the slender recurrent nerve round this vessel to the œsophagus; it then gives branches to the lungs, and passes over the right branch of the pulmonary vein to the left side to join the left trunk, after giving filaments to the pulmonary artery and vein. The left trunk near the bifurcation of the trachea sends up its slender recurrent nerve, which gives filaments to the trachea, but its principal part terminates on the œsophagus; it gives filaments to the lungs, and sends a large branch down on the œsophagus to terminate on the enlarged part of this canal near the gizzard; it then passes over the pulmonary vein after having given filaments to this and the pulmonary artery; it is then joined by the right trunk, and one chord is thus formed, which passes down on the front of the œsophagus to terminate on the gizzard, after it has communicated with filaments from the splanchnic nerves accompanying the cœliac artery.

FIGURE II.

THE NERVES OF THE STOMACH OF THE CRANE.

(ARDEA CINEREA.)

After the par vagum has given numerous branches to the trachea and lungs, and the large vessels of the heart, it sends off the recurrent on each side to give branches to the œsophagus, to the lower larynx and its muscles; it then sends a branch downwards on each side of the stomach; the rest of each trunk becomes joined in front of the œsophagus, passes on the stomach as far as the cardiac extremity, and sends filaments to communicate with branches of the splanchnic nerve as well as the one passing on the cœliac artery.

1. Right trunk of the par vagum.

2. Recurrent branch of the same.

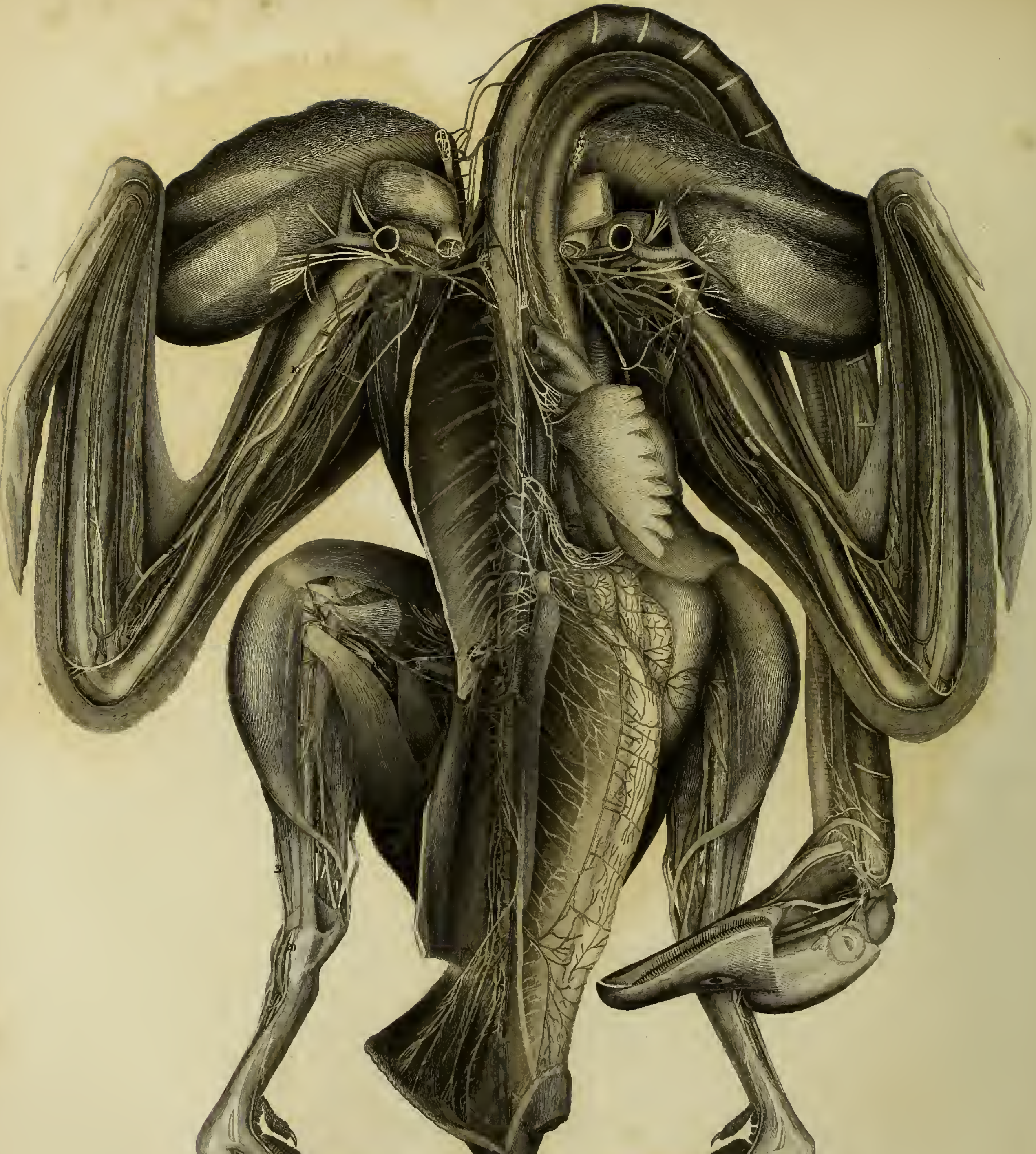

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PLATE XXV.

THE NERVES OF THE SWAN.

(CYGNUS OLOR.)

FIGURE I.

THE branches pointed out in the two preceding plates will not be particularly noticed in this.

1. First large splanchnic nerve.

2. Second large splanchnic nerve: after this has been given off, the sympathetic passes downwards and communicates with the spinal nerves; it sends some branches upwards to communicate with others from the splanchnic nerves, and give branches to the kidneys and several to the meso-colon, many of which advance forward and form an arch near to that of the meso-colic artery, which at the superior part communicates with the splanchnic nerve, and gives branches to the intestines and others to the delicate peritoneum.

3. The sympathetic communicates freely with the anterior trunks of most of the spinal nerves within the pelvis; these form several large chords, which pass downwards to the muscles and other parts connected with the cloaca and skin.

4. Spinal marrow; it passes down of nearly the same size; about the middle of the neck it is rather smaller, and at the lower part begins to increase, and becomes still longer about the middle of the portion giving off the nerves to the axillary plexus; it then gradually diminishes, and a great part of the thoracic portion continues of nearly the same size as the upper part of the cervical; towards the loins it increases again, and becomes most enlarged about the middle of the portion giving off the nerves to the

lower extremities. A little above and below this part there is a separation of the two posterior halves of the chord at the ventricle, which is covered only by membrane; the spinal marrow begins to diminish again, and becomes gradually less as it approaches the extremity of the tail. In the dorsal and lumbar portions, where no motion is allowed, the marrow fills the spinal canal, and in many parts is covered closely by a thin plate of vitreous bone. The anterior and posterior bundles of each nerve are of nearly the same size; and in one of the largest nerves, the anterior bundle could not be so clearly separated from the ganglion as in man, neither in the turtle. The cervical nerves are very numerous, each of them is divided into an anterior and posterior trunk; the anterior is given to the muscles and the skin, and the posterior principally to the muscles. The dorsal, after giving filaments to the intercostal muscles and the rudiment of the diaphragm, pass to the skin of the side; the lumbar and some of the sacral form the nerves of the lower extremity; and the rest, to the termination of the spinal marrow, are given to the muscles and skin of the cloaca and tail. In the pinion very distinct little muscles are observed for giving motion to the quills, and thus form a variety of the cutaneous muscle.

5. First of the three cervical nerves, which together with the first dorsal, form the axillary plexus. The two preceding cervical nerves communicate together, and then with the first entering the plexus, and are distributed on the muscles at the posterior part of the scapula corresponding with the trapezius, the levator of the scapula and rhomboid, and on the skin. Several branches from the plexus are given to the pectoral muscles and that resembling the great serrated.

6. Circumflex nerve; it gives a branch to a muscle analogous to the broadest muscle of the back, and is then distributed on the deltoid.

7. Internal cutaneous nerve, descending, at the inner side of the humerus, to the skin.

8. Spiral nerve: it gives branches to the teres and scapular muscles; it sends branches to the internal brachial muscle and the extensor corresponding with the triceps. In passing behind the fore-arm it gives a branch to supply the skin; at the back of the ulna it gives a branch to the radial muscle, and a muscle corresponding with the short supinator, to the external ulnar, and the other muscles analogous to the extensors of the wrist and fingers, and is then continued close to the interosseous ligament to the skin and other parts at the back of the pinion. A similar branch was traced in the pelican to the back of the pinion; it there divided into two branches, one to be distributed on the skin at the edge of the thumb, the other to the muscles and skin at the middle part as far as the extremity of the finger.

9. Median nerve passing with and giving branches to the biceps muscle.

10. External cutaneous nerve arising from the median, and descending to the skin on the outer side of the fore-arm.

11. A branch of the median corresponding with the ulnar; it passes over the inner condyle of the humerus, and gives filaments to the skin of this part, and to the internal ulnar muscle; it sends a branch down the fore-arm on the outer side of this muscle to the skin throughout the outer edge of the pinion; another branch passes underneath, and then at the inner side of the internal ulnar muscle, to terminate on the palmar face of the pinion. In the pelican a branch corresponding with the last is conveyed underneath, and adhering to the tendon of a similar muscle to supply the muscles and skin of the palmar face of the pinion, and communicate there with a branch of the median.

12. Continuation of the median nerve; it sends a branch under the head of one of the pronators of the radius and gives filaments to this muscle, and the other pronator of the radius, and passes down to the skin as far as the pinion; another branch passes behind these muscles and reaches the ulnar side of the inner pronator of the radius, and passes down the fore-arm to the pinion and divides into two branches, to be distributed on the thumb and fore-finger. In the pelican, this branch is divided in the same manner, one supplying the muscles of the thumb, and skin; the other, after communicating with the ulnar, is extended along the fore-finger to the skin.

13. Anterior crural nerve; it is formed by the first, second, and third lumbar nerves, and is accompanied by a small artery; it is given to the muscles which are in the place of the gluteal, the tensor of the fascia of the thigh, the straight muscle, the external and internal vast. and the crural, and sends off a slender branch, the saphenus, to be joined by another from the obturator to pass down on the inner side of the leg.

14. Obturator nerve: it arises from the second and third lumbar nerves, and after giving off the branch to join the saphenus, terminates on the obturator and pectineal muscles.

15. Sciatic nerve: it arises from six nerves below the third lumbar, and is accompanied by the femoral artery into the thigh, after giving branches to the adductor and the flexors at the back of the thigh, which are in the place of the biceps, the semimembranous and semitendinous, it passes down and divides into the posterior tibial and peroneal nerves; the posterior tibial divides into two portions.

16. One division of the posterior tibial nerve: it gives branches to several muscles corresponding with the inner part of the gastrocnemius, the posterior tibial and the flexors of the toes, and sends one down to the skin at the inner side of the leg.

17. Another division of the posterior tibial nerve given to the heads of muscles forming the outer part of the gastrocnemius.

18. A branch of the peroneal nerve passing down the leg behind the tendons towards the outer malleolus, and from thence to be distributed on the sole of the foot. The course of this corresponds with that of the posterior tibial in mammalia.

19. The peroneal nerve; it passes to the outer side of the leg and gives branches to the muscles, corresponding with the peroneal, the anterior tibial, and the extensor of the toes.

20. The anterior tibial nerve of the peroneal: it passes between the peroneal muscle and the extensor of the toes, and under the annular ligament, and gives a branch to the inner side of the first or inner toe, and another to divide for the outer side of the first toe and the inner side of the second.

21. Continuation of the peroneal nerve: it becomes superficial about the lower part of the leg, and passes over the annular ligament at the ancle, and then between the tendons of the second and third toes, and divides for the outer side of the second and the inner side of the third; another slender branch passes from between the muscles on the outer side of the leg, and is distributed on the skin about the outer ancle.

The brain of birds differs from that of many of the amphibia in the form, and comparatively large size of the hemispheres. In the greater dimensions of the anterior lobes, in proportion to the olfactory nerves; in the very thin parietes of the posterior part of the lateral ventricles; in the shape and magnitude of the striated bodies; in the larger size, and different situation, of the optic thalami; in the flattened summit, but greater circumference of the optic lobes, and in the shape of the cavity, which corresponds with their external form. In the external shape and appearance of the cerebellum; in its having convolutions; in the thickness of the parietes of its small cavity, which communicates with the other ventricles. In the absence of longitudinal eminences extending towards the calamus scriptorius, and forming the ventricular chord; in the greater thickness of the oblong medulla. It agrees in the presence of the anterior, posterior, and soft commissures; in crura extending to the oblong medulla, and in the similar arrangement and origin of the nerves.

It differs from that of many of the mammalia in the want of convolutions and the corpus callosum, or great commissure. In the great thinness of the posterior parietes of the lateral ventricles; in the radiated form of the septum, and the different construction of the floor of this cavity; in its being continuous with the sides of the ventricles, and not separate like the fornix. In the hollow optic lobes instead of the quadrigeminal bodies. It agrees in having small lateral lobes, similar to the lobules attached to the sides of the cerebellum in the monkey and some other animals, and also in their being placed in a hollow, partly surrounded by a semi-circular canal, which in man, and some animals, is occupied by part of the petrous portion of bone. It differs in the continuation of the third ventricle into the cerebellum as well as into the calamus scriptorius; in the want of the annular tubercle, although there is a considerable enlargement of the oblong medulla at this part.

The spinal marrow in the neck is frequently thin and narrow for allowing extensive motion, but is thicker and broader at the parts from which the larger nerves arise; it is more prominent on each side at the origin of every nerve, and thus slightly resembles the unequal chord of some invertebrated animals; but it is in shape only, and not from the presence of ganglia. It is continued to the tail. It has a distinct ventricle at the loins, which is shut only by membrane; it is closely surrounded by a thin plate of bone at the immoveable vertebræ of the back; at the same parts each anterior and posterior bundle of nerves is similarly incased. By these contrivances the effect of shocks in a part required to have firmness and immobility is diminished, which might otherwise have been communicated to the spinal marrow. The width of the canal of the moveable vertebræ shows that the space exists entirely for the free accommodation of the chord in flexion.

In the nerves there is very little difference from those of several of the amphibia. The olfactory is not so coarse; the glosso-pharyngeal is rather larger in proportion to the par vagum, but several of the nerves vary in different classes, and correspond more or less in particular kinds of each; in the goose some nerves continue more separate in their course, and supply distinct muscles, similar to those in the turtle; and in the pelican and crane are more connected, and furnished to muscles which are very much interwoven with each other.

The nerves differ from those in mammalia in the clearer connection of part of the optic nerve with the optic lobe. In the less distinct separation between the larger and smaller portions of the fifth. In the different distribution of the branches of the fifth on a greater proportion of hard parts, or the thin or membranous coverings of these, instead of thick fleshy ones, and in the less defined smaller portion. In the varying size of the different trunks, according to the parts furnished by them, but particularly in the branch of the third given to the mylo-hyoideal muscle and the skin and membrane of the fauces, it being very large in the pelican, smaller in the crane, and much less in the goose. It differs in the absence of the branch of the third trunk forming the gustatory nerve. In the less extensive distribution of the hard portion of the seventh, and its connection with cervical nerves, and not with branches of the fifth in the face and throat and neck; its supplying however cutaneous muscles in these parts, as well as the digastric and one arising from the lower jaw, which is inserted into the hyoid bone and may be compared with the stylo-hyoideal. In the larger proportionate size of the glosso-pharyngeal nerve to the par vagum in some instances, its supplying the superior glottis in the same manner as the superior laryngeal in mammalia; it sends off a branch to furnish the cerato-maxillary muscle, which then rejoins the nerve, and passing forwards, gives branches all along the surface of the tongue, communicating towards the anterior part freely with branches of the opposite nerve. In the upper larynx and trachea, not being supplied by the par vagum, and a greater proportion of the recurrent terminating on the œsophagus and crop; in the conjunction of almost the whole of each trunk into one chord below the lungs, nearly like that in the snake; and its termination either on a gizzard or fleshy stomach. The ninth varies according to the difference of the parts it usually furnishes in mammalia; in the goose it supplies the long muscle on the side of the trachea, the hyo-laryngeal, the trachea, the hyo-glossal and lingual. It may be a question whether an accessary nerve really exists; if it does, its origin and connection with the par vagum are so close as not to allow of a separation. Many of the cerebral, as well as spinal nerves, pass through osseous canals.

The par vagum, the glosso-pharyngeal, and ninth, continue more separate from each other after their exit from the cranium in the birds, having the most perfect muscles attached to the hyoid bone, the tongue, and lower jaw; and more conjoined as these parts become less distinct, as in the crane, and particularly in the pelican; and in the last the nerves and muscles are more confounded than in the snake. Notwithstanding these muscles are so slender and confused, different nerves more or less conjoined supply them; it may therefore be concluded, that each portion performs a specific function, although the action of the whole is more combined and uniform than in the goose in which the muscles are so distinct and powerful. It is very probable that the long muscle, which may be compared with either the genio-hyoideal, or the hyo-glossal in the pelican, which is supplied from the conjunction of these nerves, can draw the part of the great pouch occupying the median line into a ridge, and perform functions similar to but less perfect than those of the tongue, independently of any influence it exerts over the hyoid bone and upper larynx. Therefore, although the same nerves originate from the brain, their destination depends upon the form and uses of the several organs, so that when there are only slight variations in their actions, as in different parts of the throat of the pelican, many nerves supposed to have dissimilar functions become intimately connected with each other, and thus preserve a general but due consent between the muscles, the investing membrane of the throat, the pharynx and skin, and produce a general contraction of the muscular expansion modified to a certain extent according to the direction of the rudimental fibres.

In the pelican, the greatest part of the nerves supplying the upper and lower jaw, and the pharynx, or great bag, are covered with a black membrane, which is provided on account of the thinness of this extensive part, and for preventing any privation of the influence of the nerves, and a consequent retardation of the circulation of the blood from exposure to a low temperature. There is very little difference between the spinal nerves of birds and those of some of the amphibia and mammalia, except in the number in each region and the lower origin of the caudal, than in mammalia. The number of cervical nerves is very various, but the three inferior and the first dorsal generally form the axillary plexus, the branches proceeding from which observe a considerable similarity to those of mammalia. The number of dorsal nerves is generally fewer, and that of the lumbar, and sacral, and caudal varies, the dorsal nerves pass between the ribs nearly as in mammalia, supply the intercostal muscles and then terminate on the skin; in the pelican several of these were formed into a plexus near the wing before their final distribution on the skin, most probably for combining in action particular feathers. Nerves are furnished from the lumbar and sacral for the lower extremities, and numerous small caudal nerves for the parts about the cloaca and tail. In the crane and pelican, branches of the cervical nerves are observed to communicate with those of the pharynx and the descending branch of the hard portion. In passing down the neck in the crane, the par vagum adheres to the cervical nerves by very fine filaments, but in the pelican, although there is a similar approximation, communicating filaments could not be recognized; it is most probable, therefore, that in the crane they may be mere expansions of neurilema.

Parts covered with feathers generally receive spinal nerves, and seldom branches of the fifth; hairs in the human body and animals exist in parts supplied by both, but the longer hairs, and wool in particular, in those furnished by the spinal; there are exceptions to all these statements, it is, therefore, most probable that the structure of the skin, independently of the nerves, is a principal cause of the difference.

The sympathetic nerve has many remarkable points of difference; the superior cervical ganglion is not so distinct in the swan and goose as in the pelican, but in the pelican it is more impacted in the glosso-pharyngeal nerve, the disposition of its branches is however similar. It sends off a superior branch to communicate with the hard portion of the seventh, and with the second trunk of the fifth close to the connection of this with the third trunk, and give filaments to the lachrymal glands. The inferior branch passes with the internal carotid artery, and in the swan communicates again with the hard portion, sends a branch into the orbit to supply Harder's gland and join the first trunk of the fifth, and sends another branch forward to communicate with the second trunk of the fifth, and accompany the arteries of the palate and nose; in the pelican, the inferior branch does not appear to communicate with the hard portion, but join the branch of the third nerve given to the inferior oblique muscle of the eye, and then supply Harder's gland and become connected with the first trunk of the fifth, and furnish a branch to the palate. The cervical portion of the sympathetic may be compared with that of the snake in its not having a chord or prolongation accompanying the trunk of the par vagum, it, however, corresponds in some measure also with that of the turtle, for in the swan a branch is continued down the neck with each carotid artery, and in its course communicates several times with its fellow. In the pelican the carotid artery is a single trunk dividing into two at the upper part of the neck, a branch passes from the superior cervical ganglion with each of these, and becomes united into one near their bifurcation ; it gives off branches for the supply of the carotid artery, and to communicate with the prolongation accompanying the vertebral, at the bottom of the neck it dips down in the median line between the anterior cervical muscles and divides into two branches, each joining the last cervical ganglion, but one of the sympathetic. After it has communicated with several of the cerebral nerves, it is continued down the spine in a canal with the vertebral artery, resembling the prolongation in the imperfect canal in the snake, and the chord sent from the first thoracic ganglion and placed at the side of the neck in the turtle, and that accompanying the vertebral artery in mammalia. It adheres to the anterior trunk of each cervical nerve through a ganglion and thus forms a peculiar mode of communication. Having reached the thorax, its ganglia are connected with those of the dorsal nerves, thus resembling, in a considerable degree, the same in the turtle ; in the swan and pelican a large nerve may be seen on each side proceeding from the first thoracic ganglion to communicate with the pulmonary branches of the par vagum accompanying the large blood vessels to the heart ; the prolongation in the thorax is generally double, and becomes united at each ganglion, and gives off an upper splanchnic nerve, and an inferior one as in the turtle, which does not as in this animal form plexuses, or ganglia bearing any proportion to the size of those in mammalia; the upper splanchnic nerve accompanies the cœliac artery to the gizzard and liver, and to communicate with branches of the par vagum, and the inferior one is intimately combined with the renal capsule, and this in a remarkable manner with the ovary; it may therefore be a question whether the renal capsules are in any way concerned in reproduction; branches are given off which follow the ramifications of the mesenteric artery to the intestines; the prolongation in passing down the spine sends branches on the meso-colon to communicate with those of the inferior mesenteric plexus; also branches to the kidney, and others to communicate with the long branches of the spinal nerves destined for the cloaca and adjoining parts, and thus form a plexus corresponding in some degree with that in mammalia produced by the junction of the hypogastric plexus with branches of two or three of the sacral nerves.

The accompanying arteries of the thoracic portion of the sympathetic are two-fold like the double prolongation, one being derived from the aorta in the same manner as the usual intercostal artery in mammalia and passing before the head of the rib, the other being continued down from the vertebral behind the same process, and both becoming joined into one to form the intercostal artery. It is probable that this disposition both of the arteries and nerves is for adapting them to the peculiar form of the spine, rather than for producing any specific effect different from that of both conjoined.

Although the brain of birds is small and contains fewer parts, which usually minister to the intellect than in many of the mammalia, yet the cerebellum and oblong medulla are larger and more complex than in amphibia. The construction of the spinal marrow and nerves is not very different from that in amphibia, but the ganglia of the sympathetic are generally more distinct, and approach nearer to those of the human subject. The parietes of the left ventricle of the heart are thick and powerful, and capable of circulating quickly over the body the oxygenized blood; those of the right are much thinner and weaker in proportion, but the strong fleshy lungs compensate for the difference. The lungs are proportioned to the size of the brain, and it may be a question whether the heat of the body depends upon a more highly formed brain, a more complex and convoluted cerebellum, and a larger oblong medulla, or whether upon the more constant action of the heart and lungs, the heart being supplied in a greater degree with nerves from the sympathetic, and therefore less capable of being controlled than when it is almost entirely furnished by the par vagum.

It is difficult to determine why the sympathetic is joined so much more to the glosso-pharyngeal than the par vagum, unless it be on account of the larger supply of branches of the glosso-pharyngeal to the pharynx and larynx than in mammalia, and why this nerve is preferred to the par vagum, unless it be on account of the nearer approach of the functions of the upper larynx to those of the tongue and pharynx, and their distance in respect to the formation of the voice.

PLATE XXVI.

Fig. 1. Fig. 3. Fig. 2. Fig. 4.

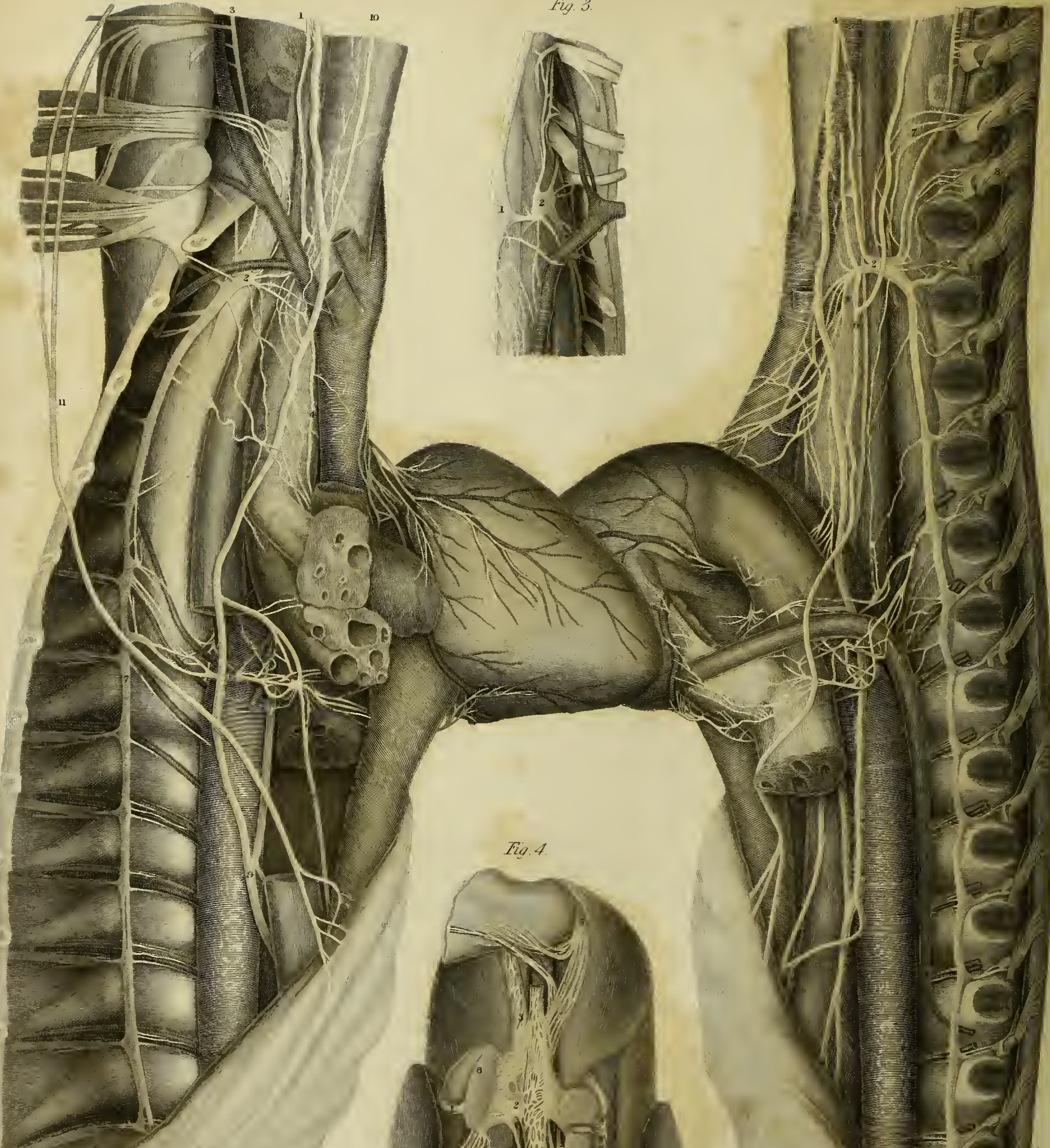

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PLATE XXVI.

THE SYMPATHETIC NERVE IN THE RIGHT SIDE OF THE CALF.

(BOS TAURUS.)

FIGURE I.

In this figure the heart is placed for shewing the right coronary artery.

1. Prolongation of the sympathetic; near the bottom of the neck it separates from the trunk of the par vagum, and sends off a branch to the recurrent nerve; it passes behind the subclavian artery and one sending off the superior intercostal, to the first thoracic ganglion, having previously sent a smaller branch to this ganglion.

2. First thoracic ganglion of the sympathetic nerve.

3. A large branch from the first thoracic ganglion of the sympathetic nerve passing up with the vertebral artery, and communicating with the cervical nerves, and following the artery into the spinal canal.

4. A large branch from the first thoracic ganglion passing behind the innominata, to which it gives filaments, and then behind the ascending aorta and the pulmonary artery, and emerging from beneath this vessel to follow the left coronary artery to the left ventricle of the heart. This termination is seen in Fig. 2.

5. Branches from the first thoracic ganglion, which communicate with others from the prolongation, and with a branch of the par vagum forming the anterior pulmonary plexus, and then pass behind both auricles, to which they are distributed.

6. Right thoracic plexus: it arises from the third, fourth, and fifth thoracic ganglia; below the root of the lung it communicates with a nerve 8. formed from branches of each trunk of the par vagum, which gives branches to the lungs; it sends some branches behind the inferior vena cava, to give branches to the left auricle and ventricle, and others

to communicate with the left thoracic plexus, accompanying the left azygos vein some way in their course towards their termination in the left auricle and ventricle ; some of its branches also pass behind the œsophagus to communicate again with the left thoracic plexus.

7. Prolongation appearing flat like tape, and composed of longitudinal threads communicating with each other, and having a slight difference in the form of a ganglion at each spot where branches are given off to the aorta and each intercostal nerve ; after the thoracic plexus is given off, it becomes much narrower: it then gradually gets broader after every communication with a spinal nerve, almost as if the branch from each intercostal nerve had been added to it, and as if the splanchnic nerve were joined to it, as it would be in man, if the prolongation and branches forming the splanchnic nerve were drawn together; it is then continued through the diaphragm into the semilunar ganglion, and forms a close connexion with the renal capsule, but just about its termination in this it sends down the prolongation to the lumbar ganglia, which send branches to the abdominal viscera, and communicate with the lumbar and sacral nerves. The branches from the semilunar ganglion are very much like those in man, but not quite so complex.

8. Smaller or anterior branch of the trunk of the par vagum: it is joined by a branch from the left side, to form a small chord ; it communicates with the thoracic plexuses, and gives branches to the lungs; it passes anteriorly on the œsophagus, then penetrates the diaphragm and receives a branch from the junction of the two nerves forming the posterior chord, and gives branches to the second and third stomachs, and a large one to pass over the third to the fourth, and to be continued along the smaller curvature of this and communicate with filaments of another branch passing in the small omentum, and forming the left hepatic plexus ; it communicates also with branches of the right hepatic plexus, which proceed from the right semilunar ganglion, and accompany the pyloric artery; branches from the left hepatic plexus, pass first on the duodenum and then towards the other branches of the anterior trunk of the par vagum just described. The trunks of the par vagum give branches to the various stomachs, and their mode of doing it seems to be more for convenience than for any difference there is between the anterior and posterior divisions of these nerves.

9. The continuation of the right trunk of the par vagum becomes joined to an equal portion of the left, and forms the posterior chord ; its junction sends a branch to the smaller or anterior branch 8, just when this has passed through the diaphragm ;

it sends downwards branches, as soon as it has passed through the diaphragm, to the plexus of the semilunar ganglia, surrounding the cardiac and superior mesenteric arteries; a great part of it then terminates principally on the great bag or first stomach, but it sends another large branch, filaments of which also communicate with branches from the semilunar ganglia sent on the arteries of the stomach, and then passes to terminate in the back of the third and fourth stomachs.

10. Recurrent nerve.

11. Phrenic nerve.

FIGURE II.

(THE LEFT SIDE OF THE SAME.)

In this figure the heart is placed for showing the left coronary artery.

1. Prolongation of the sympathetic passing to the first thoracic ganglion; about the middle of the neck a small ganglion appears to be inserted into it whilst it is connected with the par vagum, and from this small ganglion a branch accompanies an artery to the muscles on the outer part of the neck.

2. First thoracic ganglion: many branches are given off from it, which form a plexus, and give filaments to the pulmonary artery and aorta and the right auricle, and then accompany the right coronary artery to terminate on the right ventricle of the heart; the termination is seen in Fig. 1.

3. Left thoracic plexus: it arises from the first, second, third, and fourth thoracic ganglia of the sympathetic; it sends branches some way with the left azygos vein to the left auricle and ventricle, and to communicate with branches from the right thoracic plexus, coming from behind the inferior cava, and others from behind the œsophagus.

4. Trunk of the par vagum.

5. Recurrent nerve.

6. Phrenic nerve.

7. Two large branches from the sixth cervical nerve communicate with a branch from the first thoracic ganglion of the sympathetic, and then pass to be distributed to a muscle on the anterior part of the spine, and the others are connected with the first thoracic ganglion of the sympathetic.

8. Seventh cervical nerve receiving branches from the first thoracic ganglion; the

filaments of which, terminating on the spinal nerves, are very minute, and cannot be truly separated from these and traced to the spinal marrow; filaments of the branches of the sympathetic proceeding towards the spinal nerves are given to the ligaments and other structures.

9. Spinal nerve, showing how the small branches collected from the spinal marrow pass inclosed in separate sheaths of the dura mater; the ganglion is coarse and thready, and is more uneven on its surface, and contains less of the red interstitial matter than in man.

FIGURE III.

THE FOX.

(CANIS VULPES.)

1. Inferior cervical ganglion of the sympathetic impacted on one side of the trunk of the par vagum.
2. First thoracic ganglion of the sympathetic.

FIGURE IV.

THE DOG.

(CANIS FAMILIARIS.)

1. Splanchnic nerve.
2. Semilunar ganglion.
3. Hepatic plexus.
4. Superior mesenteric plexus.
5. Posterior chord of the par vagum.
6. Renal capsule.

In the sympathetic nerve of different genera and even species of mammalia there are peculiarities. The superior cervical ganglion varies somewhat in its shape, but is generally pyriform, or oval, and in many instances corresponds in bearing a proportionate size to that of the second trunk of the fifth; thus it varied with this nerve in three species of the dog. In the monkey the superior cervical ganglion is rather pyriform, the Vidian nerve is connected with that corresponding with the palatine nerve in man, and divides into two branches; the superior to join the hard portion of the seventh, and the inferior to join the sympathetic in the carotic canal: there is not, however, a distinct spheno-palatine ganglion like that in man either in the monkey or baboon. In other animals the greatest portion of the sympathetic ascending from the superior cervical ganglion passes to the part of the Gasserian ganglion, giving off the first and second trunks. In the dog the superior cervical ganglion is pyriform, and less than it usually is in man; branches ascend to join the fifth and sixth nerves, and one branch corresponding with the Vidian proceeds forwards to form a ganglion on the floor or the inferior surface of the orbit, just at the inner side of the second trunk of the fifth, and join the nerve arising from this, and dividing into the lateral nasal and palatine. In the jaguar the superior cervical ganglion is thick and pyriform, it sends filaments upwards, which communicate with the glosso-pharyngeal, and the conjoined par vagum, accessary and ninth; it sends off the Vidian nerve, which forms a ganglion on the floor of the orbit, at the inner side of the second trunk of the fifth nerve, and is intimately connected with the lateral nasal nerve, but communicates in an indirect manner with the palatine nerve; the ascending prolongation passes over a considerable part of the petrous portion of bone in many filaments, some of which communicate with the tympanine branch of the glosso-pharyngeal, but the greatest number creep over this bone to the fifth nerve, whence a branch is sent to join the hard portion of the seventh; many of the filaments appear to be continued on the inferior surface of the Gasserian ganglion, and some to communicate with the sixth, and others to be extended to the rete mirabile. The superior cervical ganglion below communicates with the first cervical nerve, the pharyngeal plexus, and the laryngeal nerve, and sends branches on the ramifications of the external carotid artery, and then gives off the prolongation to be loosely attached to the trunk of the par vagum. In the calf the superior cervical ganglion is thick and oval; it sends a branch into the tympanum to join the tympanine nerve; it communicates with the sixth, and by a branch with the hard portion of the seventh, instead of the superior branch of the Vidian as in man, whilst the Vidian, which corresponds with the inferior branch only in man, passes to the lateral nasal nerve of the second trunk of the fifth, with which it forms a ganglionic union; filaments are also sent towards the par vagum, the glosso-pharyngeal and ninth at their exit from the cranium; there is another ganglion connected with a portion of the third trunk of the fifth, termed by Arnold otic; it may also be well seen in the sheep. The otic ganglion communicates with the buccal, and the trunk giving off the gustatory and inferior dental nerves, and sends a branch to the internal pterygoid muscle: it sends a branch along the Eustachian tube, where it divides into two, one of which joins the branches of the sympathetic in the tympanum, the other terminates on the tympanum. From the superior cervical ganglion branches proceed to the pharyngeal plexus, and along the carotid artery, for supplying the coats of the branches of this and also the salivary glands. In the sheep the superior cervical ganglion is oval, two small and two larger filaments ascend from it, and appear to form a plexus, from which the Vidian passes to the lateral nasal nerve, and two branches to the Gasserian ganglion, with which they become incorporated. In the ass the superior cervical ganglion is longer, but not so thick as in the calf, and resembles very much that in man; branches ascend from it, which form a plexus round the internal carotid artery; some filaments are connected with others from the glosso-pharyngeal to be distributed on the membrane lining the tympanum; the principal portion turns forward at an acute angle, and is joined by others, it then gives off filaments to the second trunk of the fifth and the sixth, and to the hard portion, whilst the Vidian passes forward at the inner side of the Eustachian tube, and then passes in a bony canal a short distance, and joins the nerve arising from the second trunk of the fifth, which divides into the lateral nasal and palatine, but it does not form a ganglion; below it communicates with the par vagum, accessary, ninth and sub-occipital, and gives branches to the carotid artery and the pharyngeal plexus. In the pig the branches ascending from the superior cervical ganglion may be traced to the second trunk of the fifth and the sixth nerve; there is not a distinct Vidian nerve passing in a canal of bone as in the calf and ass, but the branch most resembling it can be traced on the second trunk of the fifth to the place whence the palatine and lateral nasal nerves proceed; the other branches proceeding from the superior cervical ganglion communicate with the ninth and sub-occipital nerves and the pharyngeal plexus, and send a very large branch on the carotid artery for supplying the salivary glands, and other parts on which the arterial branches are distributed.

The prolongation from the superior cervical ganglion is usually a small chord; in the baboon and monkey generally, but not always, and in the hedge-hog and rabbit it passes down the neck to the inferior cervical and first thoracic ganglia, without any intimate attachment to the trunk of the par vagum, and distributes branches in its course, but in the baboon it sometimes forms a close union with the nerve for about a third of an inch, just below the superior cervical ganglion. In the pig it only just joins the par vagum on the right side, and for a very short distance on the left, before it passes to the inferior cervical ganglion, which is quite separate on the right side, but joined to the first thoracic on the left. In many animals, as the jaguar, dog, fox, ass, calf and goat, the prolongation through the neck is attached to the trunk of the par vagum, and in the calf has sometimes very small ganglia imbedded in it, which give filaments to accompany small arteries; it leaves the trunk of the par vagum sooner or later at the bottom of the neck to form the inferior cervical ganglion, and become connected with the first thoracic. There is a plexus on each side of the neck continuous with the cardiac nerves in the baboon and rabbit, but it is not so complicated as in man; it receives from the superior cervical ganglion a slender branch, which is joined by a filament from the superior laryngeal nerve, and at the bottom of the neck by other branches from the sympathetic, the par vagum, the recurrent, and phrenic: communications then take place between the nerves of the two sides, and branches are sent to the heart, those connected with the right side principally accompanying the left coronary artery, and those with the left, the right. In the calf, the prolongation passes to a very small ganglion from the trunk of the par vagum, and from this nerve and the first thoracic ganglion the principal portion of the superior cardiac nerves is sent off to the auricles and ventricles; the inferior cardiac nerves arise from the thoracic, and will be described further on. In the ass, the sympathetic passes from the trunk of the par vagum nearly as in the calf, but the right inferior cervical ganglion is rather larger, and the left extends to the first thoracic; distinct communications exist between branches from the first thoracic ganglion, the phrenic nerve, and the trunk of the par vagum; the inferior cervical and first thoracic ganglia communicate very much with the recurrent nerves and some branches of each trunk of the par vagum, so as to form a plexus, from which branches proceed to the heart, those of the right side prevailing for the left ventricle, and those of the left for the right; others, joined by branches from the trunk of the par vagum, are given to the auricles. In the jaguar, the sympathetic, on leaving the trunk of the par vagum, passes to the inferior cervical ganglion, which on the right side forms a small ganglion, and a still smaller one on the left; these send off branches to encircle the subclavian artery, and join the first thoracic ganglion, and give off cardiac branches, which, together with others from the first thoracic ganglion and the trunk of the par vagum on each side, form communications with the recurrent nerves: the branches then pass principally to the ventricles; other branches from the trunk of the par vagum and recurrent, which have communicated with some of those given to the ventricles, pass to the auricles, but some of these are also extended to the ventricles. Branches from the first thoracic ganglion join the par vagum, the recurrent and phrenic nerves. In the dog and fox, the inferior cervical ganglion is intimately connected with the trunk of the par vagum; it is placed at the inner side of the first thoracic, the short prolongation passing from one to the other over and under the subclavian artery, it sends off branches to join others from the thoracic ganglia, from each trunk of the par vagum and the recurrent, for supplying the heart; in the fox, it appears almost as if a large branch issued from the first thoracic ganglion to join the trunk of the par vagum, and for many of the cardiac nerves to pass off after this junction. In the dog, communications between each inferior cervical ganglion and phrenic nerve can be traced. In different animals, the cardiac nerves arise higher or lower according to the position of the heart, and although altogether bearing a considerable resemblance to those in man, neither form such distinct plexuses for the auricles and ventricles, nor a cardiac ganglion, nor distribute so many branches on the large blood-vessels.

The subclavian, or other large artery arising from it, and giving off the vertebral, is generally embraced by branches passing from the inferior cervical to the first thoracic ganglion, and one or more branches are always sent up from one or both of these ganglia along with, and giving filaments to, the vertebral artery, and forming in many instances the only communication with the cervical nerves; but there is not a ganglion at each point of union, as in birds. In mammalia, the small proportion of the communicating branches of the sympathetic to the cervical nerves is very remarkable when compared with those connected with the dorsal. The thoracic portion of the sympathetic supplies nearly the same parts as in man; in the jaguar, branches from several of the thoracic ganglia of the right side unite and communicate with the right posterior pulmonary plexus, and then cross the spine to give similar branches from the thoracic ganglion of the left side, and communicate with the left posterior pulmonary plexus; thus a great resemblance to the thoracic plexuses in man is formed. In the calf, a similar plexus gives off the more inferior cardiac nerves to the left auricle and ventricle; it proceeds from four or five of the thoracic ganglia on the right side, and forms communications with the anterior chord of the par vagum, which sends branches to the lungs before it descends to the stomach; branches extend across the spine behind the œsophagus, and communicate with some from a similar plexus on the left side, whilst others pass behind the inferior vena cava, and give branches to the left auricle and ventricle, and near the azygos vein become connected with the left thoracic plexus, which also gives branches to the left auricle and ventricle. In the baboon, monkey, jaguar, dog, fox, hedge-hog, and rabbit, the prolongation is a thick and narrow chord similar to that in man, but in herbivorous animals, as the ass, calf, and goat, it is broad and flat, and composed of parallel threads communicating with each other; in the pig, its disposition is more close, but it is broader and less compact than in the dog, jaguar, and others, and contains similar close and fleshy ganglia; in the calf, small ganglia are imbedded in it, which in the ass are rather an areolar disposition of some of the threads; near the bottom of the chest, however, two or three small fleshy ganglia are observed; on the inner side, these ganglionic spots give filaments to the aorta, and, on the outer, communicate with each intercostal nerve; in the ass, it continues of almost the same breadth nearly throughout the thorax, but above the last rib but four begins to separate from the splanchnic nerve, to which, however, it adds fresh branches; in the calf, after the thoracic plexus is given off, it becomes narrower; it then, in descending, gradually gets broader after its communication with each intercostal nerve, and appears rather to have had a branch added to it by, than to have given one to, each intercostal nerve. Although the splanchnic nerve adheres so closely to the prolongation, it may, by a careful dissection, be separated from this, and resolved into the several chords of origin very similar to those in man, but not without dividing connecting filaments. It passes through the diaphragm to the semilunar ganglion, and forms a close union with the renal capsule, and then sends off the prolongation. The thoracic portion differs in several animals as to its manner of giving off the splanchnic nerves. In the baboon and hedge-hog, but not in the monkey, the splanchnic nerve forms a plexus on the sides of the bodies of the vertebræ, which is very similar to that in man; and in the baboon the right arises from two ganglia higher than the left, and extends over the heads of seven inferior ribs, the left over only five; each expands into a small ganglion at the bottom of the chest, and that of the left side forms a junction with the prolongation, but becomes again separate before it passes through the diaphragm; in the hedge-hog, the splanchnic nerve extends over the heads of the four last ribs; it receives fresh branches from the sympathetic as it descends to the semilunar ganglion, thus forming a plexus on the sides of the vertebræ, in some measure similar to that in the baboon. In the monkey, the splanchnic nerve separates from the prolongation lower down than in the hedge-hog, just below the last rib. In the jaguar, the splanchnic nerve leaves the prolongation a little above the diaphragm, and passes to the semilunar ganglion. In the pig, the prolongation, just at its passage through the diaphragm, sends off the splanchnic nerve and forms a ganglion, from which a branch is sent to the last dorsal nerve. These variations of arrangement do not seem to make any difference, either in the formation of the semilunar ganglia or the branches proceeding from them. In the baboon, there is a distinct communication between the right phrenic nerve and semilunar ganglion. The renal capsules and semilunar ganglia are of various shapes in different animals, and in the two sides of the same; there is frequently an intimate union between these and the splanchnic nerves, sometimes by fleshy ganglion, sometimes by a fibrous membrane or filaments; but it is not the same always in each species. In the baboon and monkey, the semilunar ganglion is composed of a dense membrane and some fleshy parts, but the fleshy parts are not near so large as they generally are in man; in the jaguar, a considerable portion is fleshy, and the rest a dense membrane; it is nearly the same in the dog and fox; in the ass, a small portion is fleshy and the rest membranous, but the fleshy part is not of so dense a texture as in man; in a full-grown sow, it is formed of a very delicate membrane, with some small patches of fleshy ganglion amongst it, which are much less than in the ass; in the hedge-hog, it is membraneous and fleshy. The semilunar ganglia give off plexuses, consisting of branches connected together in some instances by a very delicate or dense membrane, or a more fleshy substance, and are more or less extensive according to the magnitude or length of corresponding portions of the viscera, but the general disposition of the whole is very similar to that in man. Some branches pass on the arteries of all the stomachs of ruminating animals, as they do on those of the single one in others. The hepatic splenic, renal and spermatic plexuses, are very similar to those in man, but generally not quite so intricate, and there are similar connexions with branches of each trunk of the par vagum. When the duodenum is longer, more branches pass from the superior mesenteric plexus with the branch of this artery, to meet those proceeding from the hepatic plexus on a branch of the right inferior gastric artery; in the jaguar, branches from the superior mesenteric plexus were distinctly traced to several parts of the large mesenteric gland; in other respects, in mammalia generally, the distribution of the superior mesenteric plexus is very similar to that in man, in furnishing the small intestines, and the beginning of the large, with branches, but in being larger or smaller according to the different capacity and extent of the canal, and as it supplies the cœcum and the extensive loose portion of the colon in the ass, it appears to preponderate very much more over the inferior mesenteric plexus than it does in some animals. In the ass, the cœcum, and about six feet and six inches of the colon, were supplied by the superior mesenteric plexus, and about two feet and six inches by the inferior; in the baboon, the cœcum, and about one foot of the colon, were supplied by the superior, and about five feet by the inferior; in the fox, about eight inches of the colon were supplied by the superior, and six inches by the inferior. It is difficult to state the precise boundaries of the termination of the superior, and the commencement of the inferior, as the two meet and communicate. But in the ass the superior supplied a much larger portion than the inferior, as compared with the same in the baboon.

The lumbar portion of the sympathetic gives off several nerves, generally branches from the inner side of the three or four superior ones communicate with the semilunar ganglion, the renal, spermatic, aortic, and hypogastric plexuses; these and the rest of the lumbar ganglia, and the sacral, on the outer side, communicate with corresponding spinal nerves, sometimes with more than one, and on the inner give branches to the blood-vessels, the ligaments of the spine, the cellular membrane, and absorbent vessels and glands. In the baboon and ass, the three first lumbar ganglia of the sympathetic send branches to the semilunar ganglia, the renal, spermatic, and aortic plexuses; also in the fox, but they are, in this animal as well as the jaguar, very slender. Each prolongation, towards the bottom of the sacrum, forms one or more points of union, but coalesces on the caudal artery, from which nerves are continued for the purpose of supplying the coats of this vessel: in the calf, each prolongation terminates on this vessel in the single ganglion, from which a prolongation is continued; in the jaguar, each prolongation was traced into the tail, to be ultimately distributed on this artery.

The aortic plexus varies with the capacity and extent of the large intestines, at a greater or less distance below the cœcum, and receives preportionate branches from the lumbar ganglia; after giving off the spermatic plexus, it generally divides into the hypogastric plexuses, which become combined with branches of sacral nerves, nearly as in man, for supplying the bladder and rectum, and in the female the vagina likewise.

In the baboon and monkey, the aortic plexus is nearly the same as in man, and forms a large membranous plexus, and appears most extraordinary when compared with that of animals generally; the termination giving off the hypogastric plexuses is a broad portion of the same. In a female jaguar, the aortic plexus gives off the spermatic plexus for the ovary and uterus; at its inferior part it forms a considerable ganglionic enlargement, which gives off branches to form the inferior mesenteric plexus, and then sends off the hypogastric of each side to join branches of the first and second sacral nerves for supplying the bladder, vagina, and rectum, branches extending near to the orifice of the urethra and vagina, whilst the sphincter of these canals is furnished by branches of the internal pudendal nerve. The aortic plexus in the male dog and fox is very similar to that in the female jaguar, and forms at its inferior part a similar ganglion for giving off the inferior mesenteric and hypogastric plexuses. In a female ass, the aortic plexus is broad, and has a particular membranous appearance: the external spermatic nerve supplies the mamma, it arises from the third lumbar nerve, and communicates with the third lumbar ganglion of the sympathetic, from which a large branch is sent to the aortic plexus, and at this point of union the internal spermatic nerve is given off to the ovary, the Fallopian tubes, the round ligament and uterus ; the lower part of the aortic plexus, before its giving off the hypogastric, appears to be of a structure between the thick membrane of that in the baboon and the ganglion in the sow. In the sow, the aortic plexus is rather membranous and delicate ; it gives off the internal and superior spermatic nerves, which pass on the broad ligament principally to the ovary and Fallopian tube ; it then, on each side, forms a large ganglion, joined to its fellow by a bridge ; from each ganglion branches are sent with the inferior mesenteric artery to the lower portion of the colon ; it then gives off an inferior spermatic plexus to accompany the large uterine artery, and ramify in the broad ligament with branches of this, in a similar manner to those in the mesentery, to be distributed on the horn of the uterus ; the ganglion then sends down the hypogastric plexus to join branches of the sacral nerves. In several male animals, the external spermatic nerve communicates with a branch of a lumbar ganglion sent to the aortic plexus, and near this, but not at the precise spot, the internal spermatic nerve arises. The hypogastric plexuses are generally very similar to those in man, but more or less extensive, and combined with a different proportion of membrane. This plexus may be well seen in a calf a few days old, without any dissection, before the fat has begun to accumulate ; and in the baboon, monkey, jaguar, fox, and sow, by just separating the attachments of cellular membrane at the side of the bladder and rectum ; its demonstration was also easily made in a very young ass, but in another, presumed to be at least a year old, the dissection was tedious, as the nerves were covered by, and intermixed with, a dense membrane. It is probable that the medullary portions of the nerves of this plexus are intrinsically similar, but that they have a thicker membrane or covering from the surrounding parts, not only in the same animal at different periods of life, but under the particular circumstances to which the organs supplied by them have been subjected. These nerves will therefore be satisfactorily exhibited in some animals rather than in others, or even in man, for when they are imbedded in a thick membrane, they cannot be so easily nor entirely separated. It is necessary, in examinations with the microscope, that this variation should be borne in mind, not only with respect to the nerves of this particular plexus, but to those in other situations.

In a hedge-hog, kept for some time in spirits, branches issuing from the semilunar ganglia, and the continuation of the sympathetic, and being distributed along the cœliac and mesenteric arteries, may be seen through the transparent mesentery and meso-colon, ramifying in a very beautiful manner ; if, therefore, a disposition of the nerves appears in this creature similar to that displayed by dissection in larger animals, it may be concluded that, in the smaller, similar nerves exist, although their tenuity does not allow of their being easily demonstrated.

In a calf born without a tail, and having a constant involuntary discharge of urine, and a weakness of the lower extremities, the spinal marrow supplying the lower sacral and caudal nerves was wanting, so that it terminated in a large bulb, just at the origin of the lower nerves entering the sciatic. The middle sacral, or caudal artery, was wanting. The sympathetic of both sides communicated with the spinal nerves, and the prolongations with each other at their termination just below the middle of the sacrum, so that the remaining portion was wanting, which would have communicated with the lower sacral and caudal nerves, and have been afterwards continued on the caudal artery.

In a human fœtus of about five months old, the superior cervical ganglion was large, and the conjunction of the par vagum and ninth had some similarity to a ganglion. The superior thoracic ganglion was large, but could not be well separated from the inferior cervical; all the other thoracic ganglia were large and well defined, and had a distinct prolongation between them. The origins of the splanchnic nerve were distinct; the splanchnic nerve communicated with the large renal capsule, and passed to the semilunar ganglion, which was very extensive, and appeared to be formed more in globules than in the adult. The communication with the right phrenic nerve was seen, and all the plexuses were distinct on their respective arteries; the spermatic, however, was not satisfactorily traced. The posterior trunk of the par vagum communicated with the cœliac plexus; the hypogastric proceeded to the bladder, and at this part seemed to give filaments about the passage of the umbilical arteries. The spinal marrow was nearly perfect, but reached to the bottom of the sacrum, and all the spinal ganglia were large and well formed. In a human fœtus of about four months, the ganglia of the sympathetic throughout the thorax were like patches of white cerebral matter, coalescing with each other, and, from these, branches proceeded to the spinal nerves and the splanchnic. The other ganglia were not satisfactorily observed. The spinal marrow, however, was nearly perfect, and its ganglia well formed, and there was a ganglion at the superior part of the par vagum. The renal capsules were very large. In a human fœtus of about three months, the ganglia of the sympathetic were nearly the same as in that of four months, as well as those of the spinal marrow, but they were not so large. It would be interesting to know all the changes of the sympathetic in the fœtal state of different animals.

The sympathetic is often a slender and generally a delicate nerve, therefore its safe position has been carefully chosen. In the neck of man, and some animals, it is confined to the spine by strong cellular membrane, but in others it is joined with the trunk of the par vagum. In the thorax and abdomen, and pelvis, it is commodiously fixed at the sides of the vertebræ, but more or less inclining towards the middle of the lumbar, according to the space occupied by the origin of the muscles. It is safely conducted along arteries, as the internal carotid, the vertebral, and several more. It belongs principally to the fifth, sixth, and spinal nerves, but it is also connected with others. It is not combined with sentient nerves only, but motive ones also, as the sixth and the hard portion of the seventh. It is not necessary that it should be joined only with nerves proceeding from a ganglion, for at its very beginning it communicates with the sixth, which has not one. The separation of its own ganglia, and those of the spinal nerves, is not always distinct, as in the thoracic nerves of birds and turtles. The communicating branches are not in proportion to the size of each spinal nerve, but are frequently large for keeping up a more particular connexion between the internal organs and the external part on which the spinal nerve terminates.

In the calf, the coarse structure is well calculated for showing the connexions between the sympathetic and spinal nerves. The branches of the sympathetic can be traced close to the anterior and posterior bundles of spinal nerves with which they coalesce, but cannot be followed to the spinal marrow without violently severing communicating filaments; an apparent continuation may thus be made, but it is a deception. After general and careful observation, it must be determined that branches proceed from the ganglia of the sympathetic to the spinal nerves, and become incorporated with them after separating into minute filaments. Its texture is more fibrous, or open, in some parts of different animals. In the ass, the cervical and first thoracic ganglia are fleshy and the spinal thready; part of the semilunar is fleshy, but not of so dense a texture as in man. The other thoracic ganglia of the sympathetic, with the prolongation and the first and second lumbar, correspond with the open texture of the ganglia of the dorsal and the first and second lumbar nerves of the spine; the third lumbar ganglion, both of the sympathetic and spinal nerves, is less flat and thready; the rest of the lumbar ganglia of each are more close and oval, but still of a loose texture. In the pig, all the ganglia of the spinal nerves are fleshy, but not so large, in proportion to the size of the nerves, as in man; all the ganglia of the sympathetic are fleshy; the semilunar is formed of a delicate plexiform membrane, with some thin patches of ganglion, and all the plexuses for the abdominal viscera are very slender, until the termination of the aortic in the large ganglion at the beginning of each hypogastric plexus. The spinal and sympathetic ganglia may therefore be placed with those of the baboon, but the semilunar below those of the ass. In the baboon, monkey, hedge-hog, jaguar, and dog, the spinal ganglia are fleshy, and each bundle becomes combined in one mass; all the ganglia of the sympathetic are also fleshy and membranous, and not thready, as in many of those in the calf and goat, and in a still greater degree in the ass. Some of the ganglia of the sympathetic, which appear fleshy, are not of a solid texture, like those in man, but are formed of a congeries of closely impacted fibres.

The ganglia of the sympathetic nerve in man, and some animals, consist of a peculiar substance, in which the nerves entering them are entirely lost, and from which others proceed ; but as this structure is not absolutely necessary in animals of the same class, it is provided for modifying the nature and functions of the sympathetic, and the organs supplied by it. In whatever part of many different animals corresponding portions of the sympathetic nerve be examined, a difference of the structure of the ganglia in each region, and of the disposition of the nerves proceeding from them, will be found, as well as several variations of corresponding ones ; it is therefore most probable that each form of ganglia exercises different degrees of power, and determines some peculiarity in every region of the body, according to its particular disposition, and modifies the functions of other nerves with which it combines; but if it became merely connected with each nerve for keeping up a certain degree of communication, or if it only influenced their blood-vessels, and those of their centres, there would be a like proportion in all its communicating branches, and as there is not, it may be presumed that it gives additional powers to particular nerves for specific uses, as for promoting the action of muscles connected with the functions of the viscera, preserving a consent also with the skin, and combining several internal and external organs, as the uterine and mammary, also parts of the cranium, the horns, the hair, and the features, with the testes and ovaries. The extreme delicacy of the membranous plexuses, and the small admixture of fleshy substance in the semilunar ganglia of the pig, in which the ganglia of both the spinal and sympathetic nerves are fleshy, favour this conclusion.

In each class of animals the sympathetic varies, but much more in some than in others; in the invertebrated, the ganglia are generally fleshy ; in fishes, as the skate, the ganglia of the sympathetic are fleshy, and those of the spinal nerves are small, but inclining to be fleshy ; and in the cod, those of the sympathetic are fleshy, but entirely wanting in the spinal ; in amphibia, the variation is greater, as in the snake, frog, turtle, crocodile, and chameleon ; it is fleshy in the first cervical ganglion of the snake, but thready in all the rest, the plexiform disposition, however, varying in different portions; it is also fleshy in the spinal nerves ; it is fleshy or membranous in the sympathetic of the turtle, and fleshy in the spinal nerves; it is fleshy in the first cervical ganglion of the frog, and a mere plexus in the rest, but is fleshy in the spinal nerves; it is distinct and fleshy throughout the sympathetic of the chameleon, but the splanchnic nerves form a plexus instead of a semilunar ganglion. In some birds, the ganglia are more prominent than in others, but in all fleshy, and in the dorsal region are combined with those of the spinal nerves, as they are also in some degree in the turtle. In mammalia, the ganglia vary as to size, and shape, and structure, being either close and fleshy, or open and thready, and approaching very much to one of these states, both in the sympathetic and spinal nerves, but generally in several of both in each animal, The ganglia do not observe the same form of structure in any entire class of animals, nor even in the same species, under different circumstances. The ganglia in man have been found large in robust persons, but much smaller in the delicate, or those wasted by lingering diseases; it would therefore be interesting to ascertain what are the variations occurring in every state of the body, and particularly from the mode of feeding in animals.

The slight difference between the sympathetic and spinal nerves in some amphibious animals makes one appear to be the continuation of the other; and therefore, that there may be the same approximation in the higher classes, it shows that they approach each other in their more essential parts, and that fleshy ganglia are not always necessary. It is probable that the sensitiveness of the spinal nerves is inferior to that of the higher classes, and therefore need not be much changed to be adapted for the functions of the viscera. The constant variation in the position of the viscera during progression, and the necessity for their particular conformity and adaptation for this purpose in the snake, may make a nearer approach of their nerves to those of the muscles and skin more necessary than in others of the same class, which are in these respects somewhat differently constructed. Notwithstanding the apparent similarity of the sympathetic to the spinal nerves in the snake, it is probable that each communicating branch has its functions modified by its connection with the sympathetic, and that generally slight changes in the disposition of the filaments of any part of the sympathetic, or their combinations in different proportions of membrane, as in the membranous form in some of the ganglia and nerves, and their thicker and more solid construction in others, may alter their functions. In the skate, the ganglionic character is so peculiar as to lead to the conclusion that it has appropriate powers, and that its functions are different from those of the cerebral and spinal nerves. The sympathetic varies, in a greater or less degree, in many animals, according to its required assimilation to the several organs it supplies, but in every instance it preserves an approximation of quality to that of some of the cerebral nerves, and the nerves and ganglia of the spinal marrow, so as to constitute a concordant whole, being more complicated when it is necessary for the organs supplied by it to be more independent, and more simple when a greater similarity of functions is required.

The sympathetic, in several respects, is different from the brain and spinal marrow, but from its frequent connections with their nerves, it is doubtful whether it is quite independent of them. If the little change in the communications between the sympathetic and spinal nerves in some animals countenances the opinion that one is a mere continuation of the other, the peculiar junction of the hypogastric plexus with branches of the sacral nerves in the great plexus, distributed on the bladder and rectum in mammalia, leads to a contrary conclusion, inasmuch as that, their respective functions being different, they are united in this plexus for producing more complicated actions than either of them would have done separately. The peculiar structure of the skin may require a similar texture of the ganglia of the spinal nerves, as well as those of the sympathetic, that there may be a correspondence between the actions of the blood-vessels supplying the various parts throughout their course, and also between this part and the viscera.

The blood-vessels of particular parts may require this similarity of the ganglia, but it does not appear to be necessary for those of the whole circulating system, as the heart derives many of its nerves from the inferior cervical and first thoracic ganglia, which are not so open and thready as many of the other ganglia, and this difference, by a want of correspondence, may make the heart more independent, and less easily affected by changes of action of the skin. The superior cervical ganglion is also fleshy; it seldom communicates with any spinal nerve except the sub-occipital, and sometimes the first and second cervical: this is seen in a remarkable manner in the superior cervical ganglion of the snake. The nerves, issuing from a fleshy ganglion of the sympathetic, may therefore modify the functions of the nerves communicating with it, better than a thready one, for harmonising with the parts to be supplied; the same disposition, either of this ganglion or the branches issuing from it, is not exactly the same in all animals, and in some instances the ganglion seems to be altogether absent.

The precise variations of the skin requiring the peculiar texture of the ganglia of the spinal nerves, or of those of the viscera requiring it in the sympathetic, may be determined by extensive observation. It is probable that the perceptiveness is less when the ganglia are thready, and particularly with respect to cold; but whether it is so from every other agent may be doubted, as the fifth has not a fleshy ganglion, but has some powers more acute than the spinal nerves. Whether the skin has a modification of nerves primarily on account of its structure, its covering of hair, or the temperature to which it may be exposed, or whether the intestines primarily have it on account of the food traversing them, and their particular mode of assimilation, whether both the skin and intestines at the same time, under particular circumstances, require a proximity of structure in their respective ganglia, admits of some question. In the snake, which feeds on animal substances, and the turtle, which feeds on vegetable, a plexus is substituted for the semilunar ganglion, and this in the former arises from thready points, and in the latter from fleshy; and in the pig, which feeds on everything, the semilunar plexuses are not far removed from those of amphibia. From the situation in which the plexiform structure must be placed in the snake, it is most probable that it allows of extensive distribution and motion better than solid ganglia. The differences do not appear to depend upon any variation in the brain, cerebellum, or spinal marrow, nor always on the state of the ganglia of the spinal nerves, for, in both the turtle and snake, these are fleshy.

The sympathetic nerve appears to be especially adapted for some parts, and whilst it supplies them with peculiar powers, it at the same time connects them more or less with the rest of the body. It thus keeps up sympathies between one or several nerves and organs, and produces a series of operations independent of the sensorial portion of the brain. It furnishes the arteries with filaments for their own actions. Other arteries are surrounded by branches passing to particular organs, which thus receive a direct stimulus from the impulse of the heart. Some of its branches surround arteries, and then join cerebral and spinal nerves, therefore the stimulus from the impulse of the heart is only secondarily or indirectly conveyed to the parts on which these terminate. As all the nerves are not combined with the sympathetic nor with each other in the same manner, it is probable that many of the connections are for specific purposes, and the production of particular sympathies. It seems therefore that combinations in the brain are preferred for some uses, and between similar nerves for others; between various sorts for more complicated actions; and that the properties of the sympathetic are not adapted for the functions of every organ.

Motion and perceptibility are produced by the sympathetic nerve. If the muscular coats of the viscera have been originally endowed with peristaltic action, it is further excited by the nerves through impressions made on the mucous membrane, and sometimes through others directed from the sensorium, as the passions. The perceptibility is of a peculiar and appropriate kind, but not so vivid or capable of being appreciated by the sensorium as that determined by the brain and spinal marrow. Agreeable food excites comfortable feelings throughout the alimentary canal, but not pleasurable ones, like sensations in other parts, whilst unwholesome food causes pain and uneasiness; in a similar manner some medicines affect only particular portions of it. It may be supposed that such variations of perception can be attributed to the power of the par vagum, or different spinal nerves with which each portion of the sympathetic becomes connected, but there is no evidence that the properties of separate spinal nerves are dissimilar. It is however probable that the perceptions of the spinal nerves and those of the sympathetic are different, and are further varied or approximated according to the structure of their respective ganglia. Thus some of the nerves of the viscera may approach to those of the skin, and as the food must be more or less quickly propelled, according to its qualities and the particular circumstances attending the formation and location of the animal, so the intestines are supplied with nerves, which give them a greater or less degree of irritability. As the perceptions of the skin are not the same in all animals, and the nerves become changed in ganglia of a peculiar form, so those of the intestines issue from ganglia which are more or less connected with these, and have a similar or varied construction, and thus produce the appropriate perceptibility and action according to the peculiarity of the necessary food. Therefore the skin may have dull sensations, and in the same manner the intestines; the one suited for the inclemency of exposed situations, the other for the food to be obtained there, and both approximated for sympathy with each other. Many secretions are offensive to the skin, which has not the protection of mucus, but some things hardly affect it which irritate excessively the intestines. But it is most probable that the nearer the nerves of the intestines approach to those of the skin, the less uneasy impressions any coarse or acrid food will produce, and consequently a less speedy evacuation. The open texture of the ganglia in the herbivorous feeders of mammalia, and in both herbivorous and carnivorous feeders of amphibia, although it be easily irritated, may favour a longer retention of the food than fleshy ganglia would have done. If the ganglia were close, and fleshy, and large, and endowed with perception like that in man, the intestines might be irritated by their usual food, and propel it too quickly; for the different structure of the ganglia does not appear always to vary with a change of the organs receiving their nerves, nor altogether with that of the food, but with the necessity of a sufficient retention of it for assimilation and sympathy with the external parts. Through the fleshy or thready state of the ganglia of the spinal or sympathetic nerves, it may be presumed that the parts supplied by, or communicating with them, are made more or less subservient to each other according to the required condition of every animal. It is most probable that the coarser and more irritating the food, the nearer the splanchnic nerves, the semilunar ganglia and plexuses, approach to the thready texture, or that of the spinal nerves, in mammalia; and this state of the ganglia is found in animals which have the food transmitted through the intestines the most quickly; the coarse matters are thus more speedily removed to the large intestines, where the sacculated form, with a modified lining membrane, is better calculated for delaying it until all the nutrient particles are extracted.

Although there is a duller perceptibility of the nervous system of amphibia, arising in a considerable degree from the peculiarity of the circulation, much nervous excitement is not necessary, and therefore the open state of the ganglia may be required for modifying the action of the intestines along which, in some instances at least, the food appears to be slowly propelled. As the thready disposition of the ganglia exists, both in the pig and boa-constrictor, as well as in the turtle, it is not unfavourable to the formation and accumulation of fat.

When there is so little change in the sympathetic from the spinal nerves, it shows that there is not a very different degree of perceptibility required. As it is probable that the perceptibility of the skin varies in man and many animals, so if it be not agreeable with the nature of the food required, as well as with the process of assimilation this must undergo in the intestines, the nerves are further modified in the ganglia of the sympathetic either by the closeness or openness of their structure: they are most excitable when the ganglia of both the sympathetic and spinal nerves are fleshy, and are more sensible of the presence of coarse matters, which would irritate, if long included in the intestines; the ganglia are less excitable when the spinal and sympathetic ganglia are fleshy and the semilunar thready, and least of all when both the spinal and sympathetic ganglia are thready; and thus different degrees of action of the intestines are secured, either for detaining the more nutritious and soothing, or expediting the passage of the more rough, alimentary substances.

If the habits of different animals had not been observed, anatomical research would lead to the conclusion that a modification of function, both in health and disease, is connected with the great variation in the structure of the sympathetic nerve, and therefore that appropriate sorts of food and medicine are necessary, according to its formation: by the same rule, great allowances are to be made for deductions from experiments performed on any particular animal, as they may not be generally applicable. But as the construction of nerves, as to their breadth or delicacy, varies in individuals of the same species, and even in some parts of the same animal, and produces a more or less vigorous action, so common food and medicines will have different effects, as they have from similar causes in men. The disposition of the blood-vessels, and the state of the circulation, will also modify the functions both of the nerves and organs. In a perfect creature, there is a correspondence between the several portions of the nervous system, and the parts supplied by them in each individual, but frequently there is not, or, if it originally existed, it has been disturbed either by disease or luxury. If the diet be regulated in accordance with the dictates of nature, and in the treatment of diseases particular medicines are ascertained to be beneficial to some animals only, these differences, on a careful inquiry, will be found to be consistent with the quality and conformation of the nervous system in each. The peculiarity of the milk results from the nature of each animal, and is to a certain degree required in the young on account of the particular state of the sympathetic nerve. It is probable, too, that as variations of this nerve exist in animals of the same species, so the same food is not always agreeable or soothing to the digestive organs. A modification of the ganglia may take place on account of the change in the organs receiving branches from them. Some difference may also be required on account of the presence of ruminating stomachs, so that much of the food may not pass so quickly through the small intestines after rumination as it would otherwise have done. It is probable that, in all animals, the more nutritious the food, the less it irritates the nerves, and the longer it is in passing through the small intestines; so that even the same articles, if cooked, may have their nutrient parts absorbed in these, but, if raw, will have a much more considerable portion remaining to be extracted in the large; so that the capacity either of the small or large intestines will be very much influenced, not only by the food itself, but its mode of supply, and the animals thus rendered more or less capable of making particular exertions. Too much care, however, about the diet in a healthy body defeats the aim of the natural powers of the system. If the food be so carefully chosen and elaborated by cooking, that it is not only freed from the coarser particles, but calls in action the least degree of energy of the digestive functions, it is retained so as to be almost completely assimilated in the small intestines, and its sparing remains are more slowly transferred to the large, and here, as it produces very little excitement, it is retained; so that, independently of the astringent or laxative properties of the articles consumed, the very great elaboration of the food has a tendency to produce constipation. But by a coarser diet, as bread containing bran, the use of fruits and vegetables, much more peristaltic action is excited, the food and excrementitious matters are propelled more quickly through both the small and large intestines, and by the natural efforts expelled from the body, without the use of medicines. It may be well worth while to inquire whether the health is generally benefited by the extreme attention which some inculcate as to the choice of the diet, and the necessity of constantly endeavouring to correct the digestive functions by medicines. It is possible that food, producing a healthy mechanical stimulus in some persons, may irritate in others, and lead to inflammation or ulceration of the mucous membrane; but if these things were cautiously used before the natural powers of the digestive organs have been weakened by too officious an interference, it is probable that the comfort of each individual to the end of life would be greater than it is at present, if at the same time the natural powers of the various organs of the body were moderately exercised, and the mental faculties regularly and carefully drawn out and corrected by a moral influence.

Besides the mechanical disposition of the sympathetic nerve, its modification in plexuses and ganglia, and its peculiar properties, it will be necessary to advert to the uses of its particular disposition with respect to the various parts it connects and supplies. Although the nasal and palatine nerves are given off by the second trunk of the fifth in each animal, and are joined by a Vidian nerve, a ganglion does not always exist, and when present does not occupy the same place; but although similar functions may be produced by the simple nerves, modifications are determined by their connection with, or change of in, a ganglion. It is probable that the sense of taste is more exquisite in man than in any animal, and the surface of the palate may have nicer and more uniform perceptions from the previous change of the nerve in a ganglion; it may have likewise a closer association with the Schneiderian membrane. In the jaguar, also in the calf, it is evident that the ganglion at the termination of the Vidian nerve does not belong to the fifth, and is connected principally with the nasal branch of the second trunk of the fifth, and very little with the palatine branch, these being separate from each other. This preference appears to take place in animals, which derive so great an advantage from the sense of smelling in procuring their food; whilst in man, the baboon, and monkey, it is equally connected with the palatine nerves. Its different destination in the pig from that of the jaguar and calf may be on account of the choice of food being made more by tasting than smelling; or it is possible it may have undergone some further changes in the superior cervical ganglion, than it would have done if there had been a more distinct Vidian nerve forming a ganglion, as in the jaguar and others. In man, particularly, the Vidian may produce a consent between the eye and ear, and with the nerves of the muscles rotating the head; it may also, through the sympathetic, connect the nose and palate with the actions of the chest and viscera, as in sneezing, and with some functions of the viscera of the abdomen; the superior branch may, by its communication with the hard portion, associate the nose and palate with the ear, the face and mouth in speaking, singing, and other operations. It is probable that the Vidian and other branches of the sympathetic, communicating with the sixth and hard portion in animals, perform somewhat similar functions. The superior cervical ganglion gives branches to the pharyngeal plexus for promoting some involuntary actions of the pharynx. It sends branches on the various arteries also, for connecting the actions of these with the heart, and forms communications with other nerves for modifying their functions and promoting their co-operation and sympathy. In man, the baboon, and rabbit, the prolongation from the superior cervical ganglion is separate from the trunk of the par vagum, as it can be well accommodated to the surrounding parts; in the ass, calf, dog, and others, it is conjoined with this nerve, that it may be safely conducted over parts subjected to variations during the action of the neighbouring muscles; it leaves the trunk of the par vagum sooner or later at the bottom of the neck for forming its connection with the first thoracic ganglion, and allowing a convenient distribution of its branches. Besides its connection with the pharyngeal and cardiac plexuses, one or more branches always accompany the vertebral artery for conveniently supplying the coats of this vessel, and its branches with filaments, and forming communications with the cervical nerves, and although some branches in man pass between the muscular fibres to the cervical nerves, the muscles are not so powerful, nor the motion of the neck so great, as in many of the mammalia; and in birds the communication is made more conveniently than it would have been from the prolongation placed behind the carotid arteries, where it is very slender, and often on this account overlooked. In whatever manner the sympathetic reaches the thorax in passing from the inferior cervical to the first thoracic ganglion, it generally surrounds the subclavian, or the large artery given off by the vertebral; it is presumed, therefore, that this disposition is for a specific purpose, which will be adverted to in the observations on respiration.

The irritability of the heart does not depend upon a copious or complicated distribution of the nerves, as it exists in the highest degree when the nerves are with the greatest difficulty demonstrated, and in the fœtus a few days after birth. The supply of nerves on the large blood-vessels connected with the heart is more extensive in man than in animals, and does not exist merely for keeping up the action of the heart as the propelling power of the blood, but for associating it with the peculiar functions of many complicated organs. Although there is so great a difference between the origin, number, and connection of the cardiac nerves in man and all animals, it is generally much less between the splanchnic; and this circumstance strengthens the opinion that the cardiac nerves have more important functions in man than in animals, but not in the same degree the splanchnic.

From the manner in which the intercostal arteries pass behind the prolongation of the sympathetic, and their connection with branches joining the intercostal nerves, it may be presumed that some particular purpose is answered, as in exciting the involuntary contractions of the intercostal muscles. Some of the variations of the form and disposition of the prolongation and the origins of the splanchnic nerves must be attributed to the shapes and motion of the vertebræ, and the convenience of conducting them to the viscera, and not to any required difference in their functions generally. The closeness of the prolongation and splanchnic nerves is connected with the form and motion of the vertebræ in animals bending forward the dorsal in the calf, sheep, goat, dog, jaguar, and pig; but the prolongation may be sufficiently secure in man and the baboon, which have a greater power of bending the spine at the lumbar vertebræ, and be more conveniently situated for supplying the viscera, which become so depending in the erect position of the body.

In man, a distinct ganglion generally connects the right phrenic nerve and semilunar ganglion, but only very minute filaments passing on the phrenic artery the left. A junction has been observed on the right side in a baboon, but not in any other animal: further inquiry is, however, necessary; and although in man filaments from it have been traced to the inferior vena cava, yet the greatest portion joins the left hepatic plexus; it probably exists for connecting the diaphragm with organs supplied by the semilunar ganglion, especially the liver, which forms so great an attachment to, and exerts so much influence on, the diaphragm, in the erect position of the body.

When digestion commences, the arteries of the abdomen assume an increased activity, and amongst the rest those of the spleen; and as this organ soon becomes distended with blood, and its veins have to return a great portion of this fluid to the portal vein, which is now so fully occupied with that returning from the other viscera, it is probable that the circulation through the spleen itself becomes slow and impeded, but that its arteries, which are supplied with nerves similar to those of the other viscera, and partaking of their excited state, have their actions kept up, although the blood cannot be circulated through the spleen itself. The branches of the splenic artery furnish liberally the left and inferior portion of the stomach, but more extensively in some animals than in others, very probably because digestion is more constantly proceeding in them, or requires to be more quickly performed. It cannot be questioned that a more copious supply of blood to the stomach is thus insured, when it is most required, and as the arteries are furnished by the sympathetic nerves, the secretions, and particularly the gastric juice, are poured into the stomach more freely than they would have been without this arrangement. The extraction of the spleen, and apparent health of the animal, and its small size in birds, amphibia, and fishes, may militate in some degree against this opinion ; the difference of their digestive organs may not require it to be of so large a size, but only to direct the blood to a more circumscribed portion of the alimentary canal.

The duodenum, the small intestines and the cœcum, and a more or less extensive portion of the upper part of the colon, are furnished by the superior mesenteric plexus, which has a considerable admixture of branches from the par vagum ; in man, the baboon, jaguar, dog, fox, calf, ass, and pig, the remaining portion of the large intestines, as far as the rectum, is supplied by the sympathetic. In man and the baboon, the descending portion of the colon has an extraordinary quantity of nerves from the aortic and hypogastric plexuses, in all probability both for endowing it with higher powers for preserving it from the acrimony of, and for expediting the expulsion of, the feculent matter. The hypogastric plexuses near the bladder and rectum are joined by branches from the third and fourth sacral nerves in man, and similar ones in animals, and although they do not emerge from the same sacral foramina, a mixed power is thus produced, which is neither altogether voluntary nor involuntary, yet capable of performing both functions, so that additional security may be given to the sphincter for resisting the peristaltic action for a certain time, but not too long, also for the retention and expulsion of the urine. Thus a gradual change is made in the nerves throughout the alimentary canal ; first, in the great supply of cerebral nerves in the stomach and a less one of the sympathetic ; next, a diminished quantity of cerebral nerves, and an increased one of the sympathetic ; then a supply of the sympathetic only, when there is very little secretion, but chiefly absorption, and afterwards an admixture of this with the spinal nerves, when there is an entire cessation of the proper intestinal secretions and functions ; and lastly, the spinal nerves alone, for the sphincter and other muscles of the perineum and the skin. The kidney is furnished by the sympathetic only, the ureter also receives filaments from this as well as from the hypogastric plexus ; the bladder, which is only a reservoir, and merely secretes mucus, is supplied by the sympathetic and spinal nerves conjoined ; so it appears probable nearly the same analogy holds good with respect to the contribution of branches from the sympathetic only for the testes, and the mixed nerves, for their reservoirs, the vesiculæ seminales, and their ducts ; greater motive powers may thus be given to the ducts, as well as a more acute sensitiveness. It may be further observed that the aortic plexus, by dividing into the two hypogastric to become combined with branches of the sacral nerves, which are so intimately connected with the internal pudendal, associates the various nerves of the lower portion of the intestines, the kidneys and ovaries, and testes, and the several outlets and parts connected with the completion of their functions. These nerves, as well as the rest of the sacral and caudal, both anteriorly and posteriorly form the most extensive communications in the body, and although the several parts furnished by them are connected together in many functions, they can also be influenced by them separately.

In the ass, from the third lumbar ganglion of the sympathetic a large branch passes to the aortic plexus, and from this the internal spermatic nerve is given off and distributed to the Fallopian tubes, the ovary, and uterus, and the round ligaments. From the same part of the aortic plexus the hypogastric is given off, which in passing down sends filaments to the uterus and the remains of the umbilical artery and its surrounding membrane ; it is most probable that similar nerves accompany these arteries and the umbilical chord in the fœtus ; it then forms an intimate plexus with branches from the fourth, fifth, and sixth sacral nerves, to be distributed on the bladder, vagina and rectum. The third lumbar ganglion of the sympathetic also sends a large branch to join the external spermatic nerve, a great part of which is distributed on the mamma. The close connection between this organ and the uterus with its appendages is thus clearly demonstrated ; and although it cannot be shown in the human body or in many animals, it is in the highest degree probable that a similar participation of function is effected through the sympathetic nerve. It may be remarked, that the fibrils of the prolongation are open and flat in the several animals having the mammæ situated at the lowest part of the abdomen, and more round or compact when these organs are placed in the pectoral and abdominal regions.

In the ass, the branch of the sympathetic communicating with the part of the spinal nerve, given to the mamma, is very large, whilst it appears to be slightly connected with the other portion of the same spinal nerve; in a similar manner the sympathetic communicates particularly with the phrenic nerve, and not with the branch arising with this, which is given to the great serrated muscle. The sympathetic, therefore, must be considered as conferring peculiar properties on other nerves, and capable of combining distant organs, and particularly those in which there may be an assimilation of structure. Although in the process of lactation it may not immediately excite the secretion of milk, it may influence this secondarily; so that whilst the connection of the mamma with the uterus is thus provided for, its healthy condition is best secured by its being supplied by a sentient spinal nerve, which makes it so perceptive of distension as to place the animal under the necessity of seeking for a timely extraction of the milk, whilst an undue compression of the organ from the young in sucking is at the same time prevented. The external spermatic nerve is given to the lowest division of the mamma in the female dog and sow, and it may therefore be understood how this can sympathise with the internal spermatic of the sympathetic as it does in the ass; it may also be presumed that the sympathetic stimulus can be communicated from this to each portion of the mamma above it; it is however hardly probable, as the milk generally remains in those portions only the paps of which are constantly sucked.

A sow, which was giving suck, was dissected. A large nerve arising from the lower part of the axillary plexus, principally from the first dorsal nerve, sent a branch to the pectoral muscle, and then passed downwards and communicated with several of the external branches of the intercostal nerves, and gave branches to the cutaneous muscle, for the use of which, and for conjoining in action the external branches of the intercostal nerves, it seems to be chiefly intended. A small branch of each external branch of the more inferior intercostal and lumbar nerves is sent forward to be distributed almost entirely on the skin covering the mamma. Continuations of all but the five superior of the internal branches of the intercostal and lumbar nerves pass to the posterior surface of the mammæ, from which the principal supply appears to be derived; the sixth and seventh are smaller than those below, and about the same size as those above, which are not given to the mammæ. The external spermatic nerves are given to the lower portion of the mammæ and the absorbent glands; they are not so large as in the ass, and do not appear as if their functions are different from those of the internal branches of the dorsal and lumbar nerves generally. It may be supposed that the nerve arising from the axillary plexus, and sent downwards, exists for producing a consentaneous action of the mammæ, but it is nearly the same in the female dog and the male fox, in which there is a similar distribution of the nerves, and the same parts, except the mammæ. The internal mammary artery was continued down within the abdominal muscles; and this, with branches of the intercostal and lumbar arteries, and a large one, similar to the epigastric, supplied the mammæ; large branches of the superior thoracic ganglia of the sympathetic were traced to the beginning of the internal mammary artery; it is probable, therefore, that the mammæ are connected with different parts of the sympathetic through all the arteries supplying them, and through the communications of the sympathetic with the spinal nerves; and although in the ass the connection between the uterine and mammary nerves is so clear, yet it is not in many others, which have the mammæ differently situated, but the sympathy may still take place through the sympathetic nerve. It is difficult to understand how the sympathy between the uterus and mamma is effected when the mamma is placed at the superior part of the thorax, and is supplied only by branches of the dorsal nerves, and such filaments of the sympathetic as accompany the arteries; it may, however, be presumed, that a ganglion can receive an impression from a part its nerves are distributed on, and convey it through the prolongation to other ganglia and the nerves with which these communicate, and be determined to particular organs; so that any excitement in the uterine nerves may be propagated either to the splanchnic nerves or the lumbar ganglia of the sympathetic, and from thence through the prolongation to the thoracic ganglia, which communicate with the dorsal nerves supplying the mamma, situated in the thoracic region. As through the influence of a secretion, elaborated through the power of the sympathetic nerve, the germ is quickened at conception, it is very probable that the sympathetic communicates with, and derives some impulse from, every part of the nervous system; and that the latent spark in the perfect egg is an emanation from the nervous system of both male and female combined, and the identity in essence, if not in shape, which is to excite and conjoin with such elementary matter as will constitute the frame-work of the material nervous system and the body.

Although the mode of distribution of the splanchnic nerves, and of the lumbar and sacral portions of the sympathetic, are so very similar, yet the ganglia and nerves themselves are modified, according to the general structure of the rest of the nervous system, and most probably according to that of each of the viscera. Through the communications of the lower dorsal and splanchnic nerves, the semilunar ganglia, the cœliac plexus, and the par vagum, a connection is formed between the abdominal viscera and their muscles, and between these as the chief expiratory muscles of the lungs. The abdominal viscera, in their capacity of assimilating the food, are associated with, and appropriately controlled by, the muscles constituting the parietes of their cavity; and in that of eliminating deleterious matters, and thus performing functions in a manner somewhat similar to the lungs, they are associated with the same muscles as are concerned in expiration. Thus all these parts are excited at the same time, so that whilst they act together in purifying and disposing of the blood in the increased circulation during exercise, they have at the same time a salutary condition induced.

When the extensive range of the sympathetic throughout a large portion of the animal creation is examined, its general combination with the other nerves; its particular ones in the pharyngeal, the cardiac, the thoracic, and abdominal plexuses; and its mode of connecting together, in a greater or less degree, according to its plexuses, various organs in each particular region, and through its ganglia and prolongation those at a distance from each other; its supply to the principal portion of the arterial system and its mechanical conjunction with many of the vessels: its influence in the animal economy must be considered of the highest degree of importance. But its relation to the sanguiferous system and the great nervous centres deserves especial notice. Its beginning is placed upon the internal carotid artery, branches are sent up on the vertebral from the inferior cervical and first thoracic ganglia, others accompany the intercostal and lumbar arteries, and thus the blood-vessels of the brain, and every portion of the spinal marrow are brought under the same influence, although its ganglia be either fleshy or thready; it also regulates the action of the blood-vessels generally, as well as those supplying the nerves themselves, to some distance at least, probably through the branches, which communicate with all the spinal and some of the cerebral nerves, and thus keep up a similar degree of circulation between the nerves and their centres. The blood-vessels, however, in approaching and passing through the extremities, receive nerves from those adjacent; still it is not improbable that they are under some influence of the sympathetic, although in a less degree.

It is a matter of no slight interest, in a physiological as well as a pathological point of view, to trace through the same nerves the connections of the nervous centres with the viscera and the organs furnished by the spinal and several of the cerebral nerves, and judge how sympathies between separate portions and the whole may so readily take place, and how diseases and medicines may extend their influence in various solid substances, without the intervention of the fluids. The more the anatomical character and bearing of the sympathetic nerve are studied, the greater will appear to be its importance in the animal economy, and the more extensive its influence in health and disease. The more its functions are understood, the more successful will be rational attempts at enlarging and furthering its powers, and in the same degree will ease and comfort be secured. It is not to man alone that such benefits may be extended, but also to animals; so that, whilst the enjoyment of these is promoted, their uses to man will be more prevailing. For further information respecting the agency of the sympathetic nerve, the reader is referred to the author's *Treatise on Diseases and Injuries of the Nerves*, page 289.

As the involuntary act of respiration appears to be very much connected with the sympathetic nerve, it will be necessary to notice the manner in which it is performed.

The muscles of ordinary respiration are principally the diaphragm, the intercostal, and abdominal, but others occasionally assisting are inserted into different parts of the chest, and tend to enlarge or diminish its capacity according to the direction of their fibres. Those of ordinary respiration are supplied almost entirely by the phrenic and the intercostal branches of the dorsal nerves, which communicate with branches of the sympathetic, but are not very different from the nerves given to the other voluntary muscles.

The phrenic nerve, and the one given to the great serrated muscle, are very much alike in their origin; the phrenic, however, has particular communications with the sympathetic nerve, both in man and mammalia, which the other has not, but it is difficult to determine that the diaphragm has on this account involuntary and perpetual action. In their course they are differently connected with the surrounding parts, the phrenic being placed so contiguous to the heart that the pulsations of this organ may immediately excite it, whilst the other is kept nearly at rest.

In man and mammalia, the inferior cervical ganglion of the sympathetic generally gives off a branch which invariably passes over the subclavian or other large artery, to the first thoracic ganglion, and by its connexion with the continuation of the sympathetic underneath, assists in forming a circle round the vessel; it communicates also with the phrenic and cardiac nerves. The superior intercostal artery passes between the first and second dorsal nerves and the branches of the first thoracic ganglion connected with them. All the other intercostal arteries pass behind the prolongation of the sympathetic, and many of them also through loops formed by the junction of its branches with the intercostal branches of the dorsal nerves. Although the connexion between these arteries and nerves varies somewhat in different animals, yet their contiguity is always so close, that after exposing them by dissection and injecting water into the aorta, a very evident impulse is given at each stroke of the piston to the branches of the sympathetic nerves. In the living body the intercostal arteries, in passing behind, first pulsate against the branches of the thoracic ganglia, and through these secondarily excite the intercostal nerves and muscles. Part of each intercostal nerve is distributed on the skin after it has given branches to the intercostal muscles, and may, therefore, sympathise more readily with those of the lungs, which, on becoming overpowered by exercise, have their safety provided for by a relaxation of the pores of the skin, and a copious perspiration, which diminishes the volume of the blood returned by the veins.

The branches of the par vagum destined for the lungs terminate almost entirely on the divisions of the trachea and air-cells, for maintaining these in such a state of action as favours the ingress and egress of the air, and gives them at the same time sufficient perceptibility; for when artificial respiration has been kept up after decapitation, changes have been effected in the blood similar to those during life, and sufficient for maintaining the action of the heart. The cartilaginous rings of the trachea enter only a short way into the lungs, but their lining membrane forms the remaining part of the air tube, which is subdivided into cells. This membrane is elastic and muscular, so that when the lungs are filled in inspiration it becomes stretched, and in expiration contracted, and thus with the assistance of the chest easily expels the contained air. It may admit of a question whether the lungs have actions similar to those of the electrical organs of the torpedo, rather than the exact resemblance of the ordinary muscular contraction. When the par vagum is divided, the lungs become paralytic, and immediately after death are generally found distended with air, which they had lost the power of expelling, so that a fresh supply could not be admitted for producing a sufficient change in the blood for the preservation of life. If a portion of one trunk of the par vagum be removed, after the lapse of several months, the corresponding side of the chest is found to be permanently contracted so as to be much less capacious than the opposite one. This proves that the lungs have a capability of motion or action imparted to them by this nerve, for after its division they become passive as well as the side of the chest containing them. If the lungs were mechanically contracted or dilated by the motion of the chest, why should the division of the par vagum interfere with their action? There is an elasticity in the air-cells which continues a long time after the extinction of life, but there is also another power connected with the nerves, and this is presumed to be muscular, if not electrical.

The heart and lungs, and each side of the chest, are combined in action through the connections of the nerves of the muscles of respiration with the sympathetic, and the cardiac, pulmonary, and thoracic plexuses. If the nerves of the lungs are not connected with all the ganglia of the sympathetic which communicate with the intercostal nerves, one ganglion can have impressions ransmitted through it from several others, as in the instance of the irritated Schneiderian membrane, which from one spot can call into action all the respiratory muscles, in sneezing and coughing, in an infant soon after birth.

The act of respiration may be increased or stopped for a very short period, and so far it is voluntary, but the involuntary efforts must prevail. The heart and intestines were constructed entirely for involuntary actions, but this state would not answer for the varying functions of the organs of respiration, neither would the voluntary in creatures requiring their constant activity, and at the same time a suspension of the will in sleep. But, according to the present conformation, the voluntary muscles can be called into the greatest possible action by the will, and during its influence the involuntary be subdued, but in every interval of its exertion the actions of the involuntary muscles, through their dependence on the motion of the heart and arteries, proceed and do not allow any want of change in the blood. Thus every slightly increased arterial action promotes a corresponding degree in the respiratory organs; so that during sleep or exercise, the powers so entirely correspond as to be increased or diminished, without the least interference with any operations, either of the mind or body.

Much speculation has been entertained in the consideration of respiration in apoplexy, injuries of the par vagum, and various diseases affecting the nerves. When the functions of the lungs are impeded, there is a great disturbance in the whole system, and very distressing sensations in the chest. All the muscles that can enlarge the capacity of the chest, and allow the lungs the greatest degree of expansion, are called into action. The same effort is made in apoplexy when the person is quite insensible, and, in a more moderate degree, in sleep. In diseases, and at the near approach of death, the instinctive powers excite all the muscles, but at last the sympathetic nerves alone continue their action, for in this state the blood accumulates in the viscera, and the oppressive irritation thus produced is reflected from the splanchnic nerves to those supplying the respiratory muscles.

When the phrenic nerves are divided, respiration can be performed for many hours; when the spinal marrow is also divided, just above the part from which the intercostal nerves arise, death immediately takes place; but if the phrenic nerves, and the cervical portion only of the spinal marrow be perfect, respiration may be continued so as to support life for several days. If all the nerves of the respiratory muscles, and the parts from which they originate, be perfect, and the par vagum be divided, difficulty of breathing immediately ensues; in this instance, therefore, the imperfect changes in the blood cannot, through the uneasy perceptions of the par vagum, excite the respiratory muscles, but only through their immediate effect on the brain, or the other viscera, and from these through the sympathetic nerves.

Three powers appear to influence respiration,—the pulsation of the heart and arteries against the nerves excite the ordinary involuntary act; the instinctive powers the extraordinary involuntary act, as when ordinary respiration is impeded or not sufficient: the free will, which can be exerted in the waking hours, and in the healthy condition of the body, for smelling, speaking, singing, and other operations, the voluntary act.

The brain and cerebellum are principally composed of grey or cineritious matter, and white or medullary; the surface of each, except in a very few and limited spaces, is covered with grey, which enters also into the more internal composition of several parts. The white or medullary forms the nucleus or centre of each; branches of it are extended in different directions, which give off laminated processes covered with the grey matter, and thus form the convolutions; the grey matter terminates in points at its connection with the pia mater. Through the convolutions a great extent of surface is acquired.

In man, the brain is divided into two hemispheres, joined together by commissures; between the hemispheres the corpus callosum, or great commissure, appears with its central line, the raphe, and some longitudinal bands attached on each side to the nearest convolutions, but its exposed part is in a great measure composed of transverse fibres or plates placed with their narrow edge upwards, and their faces towards each other; these however cannot be clearly separated, as they are in some degree interlaced with each other, and particularly about the raphe. By removing the superior portions of the hemispheres in a plane with the great commissure, the extent of the white matter forming the centre or nucleus is observed.

Every brain has not the same magnitude, and sometimes the two hemispheres do not correspond; there is a great exactness in the shape and position of several parts, but not of the convolutions.

In mammalia, the brain is composed of two different substances, as in man, which have a similar arrangement, but the white matter appears to be greater in proportion to the grey. The number and breadth and depth of the convolutions vary in animals of the same genus, and those of the two hemispheres, as in man, do not always correspond; generally they are separate, and aggregated on the surface, but sometimes they are combined, as in the hedgehog and rat, and form an equal and more extensive surface than when convolutions exist. The shape of the brain varies, being rounded or oval, or more or less narrow anteriorly or posteriorly, or rising to a greater height from the base. The posterior parts of the hemispheres cover the cerebellum in the baboon and monkey; in some they do not entirely, as in the jaguar, dog and fox; in others still less, as in the horse and sheep; not at all in the hedgehog; whilst in the rat, a portion of the quadrigeminal bodies is exposed. The superior parts of the hemispheres in some animals faintly exist, but in all are generally much smaller than in man, and particularly in their proportion to the oblong and spinal medulla and the nerves; their greater or less separation depends upon the size of their superior parts, and on the same circumstance the depth at which the great commissure is situated, as well as its dimensions. The structure of the great commissure is nearly the same as in man, but when very small the fibrous layers of the oblong medulla proceed directly to the surface of the brain.

In man, between the lateral ventricles the transparent septum is placed, and is formed of a double fold proceeding from the fornix to the great commissure, the anterior and upper part of which leaves a small intervening space in ascending from the anterior crus of the fornix and the cribriform lamina. Each ventricle extends forwards into an anterior horn, backwards into a posterior, and downwards and forwards into an inferior. The fornix is placed in the middle of the floor of the ventricles, and forms the roof of the third; its anterior part is connected superiorly with the great commissure, and the transparent septum; each crus is connected externally with the anterior point of the tænia, whilst internally a large proportion of it descends just behind, and attached to the anterior commissure to be joined with the anterior and inferior part of the thalamus and the mammillary eminence; in passing backwards it is connected superiorly with the transparent septum and the great commissure; its base is unattached, and leaves anteriorly the space, termed foramen of Monro; each crus passes into an inferior horn, and becomes joined to the great hippocampus, and its lowest extremity is inserted into a convolution, which forms the inner and upper boundary of the inferior horn, and is continuous with the great hippocampus. Just above this part its inner edge is unattached, and allows the choroid plexus to become connected with the pia mater. In each lateral ventricle, the striated body is placed, and rather more backward than its broadest portion the projecting part of the thalamus, and between these the tænia, which is a semicircular medullary band extending, from the outer side of the anterior crus of the fornix, backwards on the outer edge of the thalamus. The parietes of the posterior horn appear to be chiefly an extension of the great commissure, and are sometimes continued backwards to the extreme point of the posterior lobe, and form the small hippocampus. In each inferior horn, besides the posterior pillar of the fornix already mentioned, the great hippocampus is continued downwards and forwards; it is a large cornuated prominence, its medullary surface is extended to the great commissure, it is tuberculated at its lower part, and has its base formed of a convolution of grey matter, placed at the inner margin of the middle lobe. Smaller eminences are seen at the inferior part of the horn. The choroid plexus occupies more or less space in the ventricles, it becomes connected with the pia mater near the termination of the posterior pillar of the fornix, it meets that of the opposite side underneath the anterior portion of the fornix, and sends backwards on a process of pia mater branches to the vein of Galen.

In mammalia, the dimensions of the lateral ventricle and the transparent septum vary with the extent of the great commissure. The transparent septum is generally thicker and narrower than in man, and very small in rodent animals. In some, as the horse and sheep, the anterior horn is continued into the cavity of the great tubercle of the olfactory nerve. In the baboon and monkey, in the place of the posterior horn there are two small angular excavations and a very slight eminence connected with the superior and posterior point of the great hippocampus. In the baboon and monkey, the fornix is thin and small, and proportioned to the size of the ventricles; the attachments of its anterior pillars are the same as in man, and the posterior join the hippocampus, but their loose edge is not fimbriated. In many animals, it is much larger, in proportion to the size of the ventricles, than in man. In the goat, sheep, and others, its anterior extremity is connected with the great commissure, and with the convolutions at the inner margin of the base of the striated body, or that forming a portion of the origin of the olfactory nerve; a process is continued to the mammillary eminence, and a smaller one to join the thalamus; its body is unattached, and placed over the third ventricle, and conceals more of the thalami than in man; its posterior pillars have not a loose edge, but become involved in the hippocampus. The inferior horn generally winds downwards and forwards as in man, and contains the great hippocampus and choroid plexus. The great hippocampus in the monkey is continued down nearly as far as the projecting point of the middle lobe, and appears to be solid, and combined with the convolutions at the posterior and inner margin of the lobe, and is not seen at the base of the brain, as in the horse, goat, and others, but in these its parietes are thin, and connected in the ventricle with the inner surface of the prominence forming the origin of the olfactory nerve, on the lowest part of which there are two small eminences; its concave or outer surface lies partly on the thalamus, and partly on the optic tract, and at the base of the brain its conjunction with the large prominence giving origin to the olfactory nerve is again seen. In the rat, the great commissure is very small, but the fornix and hippocampus are so large as to occupy nearly the whole lateral ventricle.

In man, the striated body is broad and round anteriorly, but becomes gradually narrower posteriorly; its surface consists of grey matter, but beneath this the medullary fibres of the crus of the brain, in ascending to the great commissure, become intermixed with it. The thalamus is connected with its fellow by the soft commissure, and the space between them is the third ventricle; superficially, it consists of medullary fibres tending to and continuous with the optic tract, and beneath of grey matter, with which the fibres of the crus of the brain become intermixed in ascending to the great commissure. The anterior commissure is placed in front of the third ventricle, and over the passage to the infundibulum; it passes behind the connection of the cribriform lamina with the transparent septum, and before and attached to the crus of the fornix, and is continued outwards and backwards to the middle lobe of the brain, as far as the roof of the lower extremity of the inferior horn of the lateral ventricle, to be intermixed with the crescentic fibres of the great commissure, connecting the anterior and middle lobes just above the fissure of Sylvius. The posterior commissure is situated at the posterior part of the third ventricle; it is stretched across the passage to the fourth, and joins together the thalami near their connection with the crura of the brain, whilst the soft commissure combines more particularly their surface.

The striated bodies and thalami are nearly the same in mammalia as in man, as well as the anterior, posterior, and soft commissures. The tænia, or medullary line, situated between the striated body and thalamus, exists only in mammalia. In the baboon and monkey, the anterior commissure may be traced to the middle lobe of the brain, as in man. In the sheep, the anterior commissure is situated in front of the anterior pillar of the fornix, to which it is attached; it is divided into branches, which pass forwards and outwards, to be connected with the anterior portion of the brain, and the origin of the olfactory nerve.

In man, on removing the vein of Galen, at its entrance into the torcular of Herophilus, and the process of pia mater placed underneath the fornix, the pineal gland is seen sending forward a process on each side of the thalamus, and backwards a medullary plate to the nates, in the middle of which are some transverse fibres; rather beneath and behind this are the quadrigeminal bodies, the two anterior and larger the nates, and the two posterior the testes. They consist of grey and white matter, having a surface somewhat similar to that of the convolutions. They are united anteriorly with the thalami, laterally with the geniculate bodies, and the oblique olivary chord, and posteriorly with the superior pedicles of the cerebellum and the valve of Vieussens. The geniculate bodies are smaller eminences, placed more externally.

In mammalia, the pineal gland is found in the same situation as in man: it varies in shape, and has processes extending forwards to the thalami, and backwards to the nates. There is a considerable variety in the proportion of the nates and testes to each other. In the baboon, the nates are much larger than the testes. In the monkey, the nates are nearly round, but rather flattened at the top, and not much larger than the testes. In the pig, and in herbivorous animals, the nates are much larger than the testes, as in the sheep and horse, and in the carnivorous the testes are the largest; but the testes of a sheep are much less than the nates of a dog, and the nates of a sheep preponderate very much over its testes, much more than the testes of a dog do over its nates. In the jaguar, the common cat and dog, the surface of the nates is broader and flatter than that of the testes, but these are more prominent, and extend further laterally, and the geniculate bodies are large. In the rat, the nates are longer, but less broad than the testes. In the horse, the quadrigeminal bodies are connected anteriorly with the thalami, and a little below the surface of these with the optic tract, laterally with the geniculate bodies, and the oblique olivary chord, posteriorly with the superior pedicle of the cerebellum, and the valve of Vieussens.

In man the base of each hemisphere of the brain has three lobes; the anterior and middle are distinctly defined by the fissure of Sylvius, but between the middle and posterior there is not any decided separation. A little behind the anterior margin of the brain each olfactory nerve is continued from its bulbous extremity, between the two convolutions near the median line, to its attachments at the posterior part of the anterior lobe; behind these is placed the cribriform lamina, affording a passage to numerous blood-vessels; it extends inwards and upwards at the side of each median fissure to the anterior and inferior portion of the transparent septum, outwards to the fissure of Sylvius, and backwards to the mammillary eminences and the crura of the brain; it is also attached to the optic tracts, and around the infundibulum. Behind the olfactory, the optic nerves and their commissure are seen, and the tracts passing on the outer side of the crura of the brain towards the thalami. At the posterior part of the optic commissure is the infundibulum, its inferior extremity being attached to the pituitary gland; behind the infundibulum the mammillary eminences are seen, and behind these the third nerves in the sides of the hollow left by the diverging of the crura of the brain from the annular tubercle. The crura of the brain are chiefly formed of longitudinal medullary fibres, and have in their centre grey or black matter.

In mammalia, the base of the brain is very different from that in man; in the baboon and monkey, the anterior lobes are very small in comparison with the middle ones, but they are separated by the fissure of Sylvius: in many animals, there is no division into lobes, and very few convolutions are apparent. In the baboon and monkey, the origin and size of the olfactory nerves correspond, in a considerable degree, with the same in man, but in many instances the origin extends over a great part of the base of the brain; posteriorly and internally it is connected with the inferior portion of the hippocampus; anteriorly, very little more than the large bulbous extremity of the nerve is detached. The commissure of the optic nerves is less broad than in man; in the horse, the pituitary gland appears to be composed of two substances, one like the cerebral matter, the other like the renal capsule; the crura of the brain are larger and longer, which the small size of the annular tubercle leaves more exposed; and they are longer in the goat and sheep than in the dog and fox; the origin of the third nerve is nearly the same; the cribriform lamina hardly exists, and the mammillary eminences vary in appearance, being frequently, as in the horse and others, more like a single indistinct prominence.

In man the cerebellum is divided into two hemispheres by a median furrow, in the upper part of which the superior vermiform process is situated. The hemispheres are separated by the transverse fissures into numerous convolutions, grouped together in lobes. The convolutions are more minutely separated than in the brain, and differently connected; their surface is oblique and angular; they are formed of grey matter externally, and radiated laminæ of white internally. A perpendicular section, either of the hemispheres or the vermiform processes, presents an arborescent appearance, so that the vermiform processes are only smaller lobes, portions of which form a medium of communication between the two hemispheres. The laminæ of white matter tend towards a trunk or nucleus, which on each side has three principal terminations termed pedicles. The anterior gives off the anterior medullary velum, which covers the passage from the third to the fourth ventricle behind the quadrigeminal bodies, and is also attached to the testis and the oblique olivary chord. The middle or inferior pedicle, or crus of the cerebellum, is continued into the annular tubercle, and the posterior into the restiform body. If a perpendicular section of either hemisphere be made at about one-third of the distance from the middle line, the ciliary body is exposed; this consists of convoluted lines of grey matter, unequally extending about half an inch in the medullary nucleus.

At the base of the cerebellum the division into the two hemispheres is further seen; the fissure between these is much wider than that at the upper part; it contains central lobes, which form the inferior vermiform process; on each side of this the almond-shaped lobe is situated, and near the oblong medulla a very small one, the flock. The posterior medullary velum is a thin semilunar plate, attached posteriorly to the lateral connection of the inferior part of the vermiform process with the medullary nucleus; its anterior edge is free, but is connected at its inner corner with the outer margin of the lowest part of the vermiform process, and at its outer corner with the inner angle of the flock.

The cerebellum varies in form and size in mammalia, but the lateral lobes, however small, may generally be compared with those of man; and the middle, however large, with the vermiform processes. But it varies in the greater or less proportion of the lateral lobes to the middle, generally in the less, and in many instances in the presence of lateral lobules attached at the outer side of the inferior portion of the lateral lobes in the baboon, monkey, and rat, and these correspond with the rudiments of lateral lobes in birds, and are fitted into similar cavities, left by the less close adaptation of the surrounding bone to the semicircular canals. It varies in the different shape of the lobes, in their being placed more or less backwards, and more or less underneath the posterior lobes of the brain, and consequently in having their superior parts more or less exposed. The convolutions also vary, and are thicker and shorter in some, narrower and longer in others, but there is the utmost variety in their shape and mode of being aggregated for producing the general form of the whole cerebellum.

The convolutions of the cerebellum are aggregated in mammalia and birds, and combined for the most part in animals below these, and although there is a slight convoluted appearance in some fishes, it is not so complex as in birds. In mammalia, the cerebellum appears to be more connected with the oblong medulla than in man, and still more in the other classes, as there is not an annular tubercle.

In man, the annular tubercle extends from the crura of the brain to the oblong medulla; it is about an inch in length, and rather more in breadth. Anteriorly it is folded a little over the crura of the brain, and posteriorly over the oblong medulla; laterally, towards its posterior part, it is connected with the crura or inferior pedicles of the cerebellum. It consists of transverse fibres, tending towards the middle or inferior pedicle of the cerebellum; about the middle, and quite on its outer side, the fifth nerve is placed; at its posterior, and near its median line, is the sixth, and more outwardly the hard portion of the seventh; both of these are in some measure connected with it. The continuation of the fibres from the pyramidal bodies, and the oblique olivary chord, become intermixed with its transverse fibres and the grey matter.

The annular tubercle is much less in mammalia than in man; it however corresponds with the size of the inferior pedicle of the cerebellum, of which it appears to be the continuation, whilst the crura of the brain are proportioned to the size of the oblong medulla. In many of the mammalia a band of transverse fibres, forming the trapezoid body, is stretched across the upper part of the oblong medulla, just below the annular tubercle; but it is much less distinct in the baboon and monkey than in the horse, sheep, dog, and others; in all of them it seems to correspond with a few of the transverse fibres of the annular tubercle in man, as the sixth and the hard portion of the seventh in some measure originate from it.

In man, the oblong medulla begins at the posterior margin of the annular tubercle, and extends to the decussation of the anterior pyramidal bodies. It is composed of white and grey matter; it is fibrous, but many of the fibres cannot be distinctly separated without destroying the conjunctions with surrounding parts. The form of the grey matter varies in different places, but throughout the spinal chord preserves a great uniformity. Each half of the anterior surface of the oblong medulla has, next the median line, the pyramidal body, then the olivary body, and still more externally the restiform. The sixth nerve appears in the furrow between the lower margin of the annular tubercle and the pyramidal body, and is frequently connected with both these parts; more outwardly in this furrow, near the head of the olivary body, is the hard portion of the seventh, proceeding from the oblong medulla, and the posterior part of the annular tubercle, and still more outwardly the auditory nerve, proceeding from the fourth ventricle, and connected with the restiform body, and the crus of the cerebellum; by the side of the furrow between the olivary and restiform bodies, and originating from the restiform are the origins of the glosso-pharyngeal nerve, the par vagum, and part of the accessory, and close to the groove, between the olivary and pyramidal bodies, arising from the pyramidal body, the ninth nerve.

The posterior surface of the oblong medulla has different eminences and divisions. The posterior pyramidal body on each side has two rounded upper extremities; it passes down on the middle of the surface of the spinal chord; it adheres on the outer side to the posterior part of the restiform body, and on the inner to the ventricular chord descending on the floor of the fourth ventricle, and continued down the spinal chord with this, within the line at which the posterior bundles of the spinal nerves issue forth. The fourth ventricle is seen with its tapering extremity, the calamus scriptorius, also the origin of the auditory nerves.

Some portion of each anterior pyramidal body is continued upon the middle of the anterior surface of the spinal chord, whilst the rest passes in the interior, and decussates fibres of its fellow, forming a strong interlacing; from this it ascends in a flat band to the annular tubercle; it then separates into layers, which are intersected by and connected with the transverse fibres, and the cineritious matter of the annular tubercle, and afterwards become continuous with the crus of the brain.

Each olivary body is formed of transverse fibres of grey matter, and is continued in a capsule between the anterior pyramidal and the restiform bodies; it sends out a process at its upper extremity to the oblique olivary and ventricular chords; at its posterior part it becomes also connected with the ventricular chord.

Each restiform body is connected with the posterior pedicle of the cerebellum, and consists of complicated fibres. On the posterior part it adheres almost entirely to the posterior pyramidal body, and on the anterior to the olivary body and the anterior pyramidal.

On the posterior part of the oblong medulla each ventricular chord is placed behind the decussating portions of the anterior pyramidal bodies; it forms a band of longitudinal fibres passing on the floor of the fourth ventricle; it receives fibres from the inner part of the posterior pedicle of the cerebellum; its external edge passes underneath the inner border of the anterior pedicle of the cerebellum, from which it receives fibres; it extends also underneath the quadrigeminal bodies and the posterior commissure, to the superior part of the crus of the brain.

The oblique olivary chord is connected with the superior extremity of the olivary body and the anterior pyramidal; it is bent upwards to the crus of the brain, and in passing through the annular tubercle forms combinations. Soon after it has left the olivary body, its superior or posterior surface is almost in apposition with the anterior surface of the ventricular chord; it is also attached to the anterior pedicle of the cerebellum and the roof of the passage from the third to the fourth ventricle, and is continued to the quadrigeminal bodies and the thalamus; processes from its anterior or inferior surface become connected with the crus of the brain.

The several portions of the oblong medulla and the annular tubercle combined form the communications between the spinal marrow, the cerebellum, the brain and nerves. Each anterior pyramidal body, after its connection with the annular tubercle, the crus of the brain, and the inferior layer of the oblique olivary chord, forms the inferior communication; the anterior pedicle of the cerebellum, the ventricular chord, on the floor of the fourth ventricle, the superior layer of the oblique olivary chord, and the quadrigeminal bodies, form the superior communication. Fibres from these are continued through the thalami and striated bodies, and become intermixed with those of the great commissure; from this combination processes are sent to form the parietes of the ventricles, the transparent septum, the fornix and the surface of the hippocampus, whilst others pass in various directions, and separate into thin plates to be combined with grey matter in the convolutions.

Although there is such an extensive and similar combination of the fibres passing from the oblong medulla to the great commissure, and from this to the convolutions or other part; it is very probable that an appropriate track in the brain belongs to the nerves of each portion of the body for their particular functions, whilst they are associated with other parts through the communicating fibres.

In mammalia, the oblong medulla is generally of large size compared with the brain: it is, however, in many respects similar to that in man. It appears broader and flatter in the dog and fox than in the sheep and goat. The fibres of the anterior pyramidal bodies may be traced to the crura of the brain, and from these either directly to the convolutions, when the upper parts of the hemispheres are very small, or when larger through the great commissure; these fibres are not placed in an uninterrupted series, but are intersected by, and intermixed with, others, particularly in the annular tubercle. In some animals, the decussating bands near the spinal marrow are not so distinct as in man, but are more confused. In the horse, the whole of each pyramidal body does not decussate, but a part is continued down on the middle of the anterior surface of the spinal chord; the ascending portions at the median line communicate with each other and the trapezoid body in their course to the annular tubercle and the crura of the brain; but the fibres are not so much interrupted or interlaced in the annular tubercle as in man.

The posterior pyramidal bodies are nearly the same as in man: the rounded superior extremities, however, vary in different animals; in some, as the horse, they hardly present any prominence, whilst they are very distinct in the fox. The fourth ventricle and the origin of the auditory nerves are nearly the same as in man.

The olivary bodies do not frequently appear distinct in shape, as in man; they are present in the baboon and monkey, but not so prominent.

The restiform bodies are formed by the posterior pedicles of the cerebellum; they present the lateral prominences of the oblong medulla, and are placed between the anterior and posterior pyramidal bodies.

The ventricular chords on the floor of the fourth ventricle are nearly the same as in man, and similar to those in amphibia and fishes.

The oblique olivary chords are much thicker than in man. In the horse and sheep, one portion of each passes obliquely to the root of the quadrigeminal bodies; it is connected with the anterior pedicle of the cerebellum and the testis, and is continued to the base of the nates and to the thalamus; these parts, with the ventricular chord, are connected together, and form the superior communication with the brain, as in man; whilst the other portion of each oblique olivary chord, passing to the crus of the brain to join the fibres continued from the anterior pyramidal body, forms the inferior. In the sheep, they are nearly the same.

The texture of the grey matter of the brain is more delicate than that of the medullary; it is probable that it approaches the nearest to the essential part of the nervous system. It gives new or additional powers to the medullary fibres intermixing with it. It is copiously supplied with blood. The white or medullary matter is composed of coarser fibres or laminæ than the grey; it is the connecting medium between different parts of the brain, and between these and the spinal marrow. It is supplied with only a small proportion of blood. Neither the grey nor white matter alone, nor in conjunction as in the convolutions, appear to be perceptive of primary impressions, such as those constituting the senses, or pain; but each of these is determined by a peculiar arrangement. Through the convolutions a wide extent of surface is acquired; but whether their form, their larger or smaller size, and consequently their division into a greater or smaller number, or their collection into particular groups, always produces a change of function, remains to be ascertained. It is probable that different faculties are determined by some of these variations. It may be a question whether, according to their depth and number, by dividing the surface of the brain, they do not in a greater or less degree prevent the effects of shocks; and whether the more minute separation of various portions of the cerebellum answers the same purpose, and makes a ventricle in mammalia unnecessary. The base of the brain is sometimes divided into lobes, but in numerous instances there is very little separation; there does not appear to be any reason for the difference except for safety and convenience, on account of the shape of the head and its position relatively to the motion of the body.

The great commissure connects the two hemispheres, and particularly the superior parts, for combining the convolutions with each other, and more extensively with the fibres of the crura of the brain, after these have traversed the striated bodies and thalami; it thus forms a central conjunction of the various parts of the brain with the cerebellum, the annular tubercle, and the oblong and spinal medulla. It is difficult to determine that there is a distinct decussation in it, so as to lead to the conclusion that impressions made on one side must be conveyed to the nerves of that opposite, but there is nothing to preclude the probability that such an interchange may be made through its instrumentality; but as facts, ascertained both by morbid anatomy and experiment, prove that only some impressions pass to the opposite side from particular localities, it is not to be expected that, in the extensive connection made by the great commissure between the two hemispheres of the brain, there would be more than a partial intermixture of the fibres of one side with those of the other, as other decussations take place in their respective localities, as in the commissures of the optic nerves and the pyramidal bodies; but in whatever way the union is effected, it is clear that the two sides are conjoined through the commissures, in a great measure, for producing one harmonious concentration in the indivisible mind, as this perceives the two impressions, when parts of one hemisphere are perfect and of the other deranged.

From the situation of the anterior commissure in the sheep, it is probable that it connects the origins of the olfactory nerves; and this opinion is not invalidated by its course in man, the baboon, and monkey, as in them it reaches to the middle lobe, near the fissure of Sylvius, into which one of the roots of the olfactory nerve is extended. The posterior commissure forms a combination between the optic nerves at the connection of the fibres of the crura, which traverse the thalami towards the convolutions. The soft commissure connects the surface of each thalamus, which constitutes a portion of the origin of the optic nerves.

The mechanical bearings of the fornix may have required the connections it makes to the various parts along which it passes. In birds, its resemblance is a continuation of the parietes into the floor of the ventricles, which in the middle form a striated septum, for connecting the two hemispheres, instead of the transparent septum and the great commissure.

Ventricles are formed in the brain of all the four superior classes of animals, and are more spacious in some than in others. In the baboon and monkey, as the posterior portion of the brain is not so extensive as in man, the posterior horn of the lateral ventricle is a mere rudiment. The shape of the great hippocampus prevents the parietes of the posterior horn from coming into close contact. It is probable that the ventricles exist principally for taking off shocks, which might disarrange the functions of the solid brain. Their parietes afford a convenient extension for the attachment of particular convolutions. The difference of the shape of the brain of birds, and the uses of the parts containing it, make some variations in the ventricles necessary; the thin parietes at the posterior part are calculated for expending shocks communicated from the forcible action of the bill, better than if the ventricles were situated as in mammalia. It may be a question, whether the fornix and great hippocampus are not, in a considerable degree, subservient to the preservation of the form of the ventricle, and if they minister to particular faculties, whether they do not extend the influence of the olfactory and optic nerves in mammalia, and whether the floor and the thin posterior parietes of the ventricle in birds do not favour the functions of the olfactory nerves. As in birds, and other creatures exposed to violent shocks and injuries, the cavities extend into several portions of the brain, so in the formation of the fœtus the previous hollowness of some solid parts, as well as the late completion of others, may prevent derangements of the delicate nascent structures.

If the striated bodies give origin to the olfactory nerves, it may appear improbable that they allow fibres from the crura of the brain to pass through them for other purposes. This arrangement, however, extends the perception received at the origin of the olfactory nerves through the great commissure to the convolutions; for the sensorium is ready for receiving impressions through a common track, from separate localities giving origin to particular nerves.

The surface of the thalamus forms one of the principal origins of the optic nerves, and probably is the seat of the perceptiveness of light, whilst the fibres of the crura passing through it extend the optic faculties to the sensorium. The powers of the optic nerves are further increased and varied by the size and shape of the quadrigeminal and geniculate bodies, and the greater or less decussation of the tracts in the optic commissure.

The varying state of the quadrigeminal bodies shows that peculiar functions are attached to the changes of their form and size. There is a decided difference between them in some carnivorous and other animals, but it is a question for what purpose this exists. The fourth nerve is the same, whether the testes be large or small. The quadrigeminal bodies are presumed to belong to vision, but in what degree is not clearly ascertained. The uses of the pituitary and pineal glands are not known; they are different from all other glands; they resemble ganglia, and in several respects those placed above and below the œsophagus in some invertebrated animals.

The cerebellum has greater variations of form than the brain, and therefore may possess a special and independent power. In birds, and some of the mammalia, its surface is convoluted, whilst that of the brain is smooth. A corresponding complexity is not therefore necessary in both; but whether it be small or large, as compared with the brain, smooth or convoluted, solid or hollow, similar nerves exist, and in many respects similar organs throughout the body. Convolutions are generally present in animals with warm blood. In mammalia it has not a ventricle. It is never so large as the brain, but in its size varies in different instances. In the snake and frog it is so small as to make a comparison with that of animals in general almost inadmissible; in both, however, there are anterior and posterior bundles of spinal nerves, so that there is no correspondence between its size and the quantity of motive nerves. It has been supposed that it presides over involuntary motions, also that it is the regulator of motion. The last attribute may be countenanced by its small size in creatures whose actions are nearly uniform, either from the simplicity of shape of the whole body, or the constraint arising from the form of the bones and joints, the attachments of the muscles, and the unyielding texture of the integuments.

The crura of the brain are large in proportion to the size of the oblong medulla: they are considered as the continuations of the pyramidal bodies; they have, however, received more or less additional matter from the annular tubercle. They contain black matter, which seems to be in the place of grey, for still further enlarging their powers.

The crura of the cerebellum are more simple than those of the brain, as they are composed almost entirely of medullary matter, which becomes expanded chiefly in transverse fibres over the surface and within the annular tubercle, where they become intermixed with those of the pyramidal body and the oblique olivary chord, and thus, through the annular tubercle, combine some of the functions of the brain and spinal marrow with those of the cerebellum. If the nerves of mammalia only be examined, it may be supposed that some of them at least partly originate from the peduncles of the cerebellum; but in the snake and frog the very diminutive cerebellum must be overlooked as their real origin, which must be conceded almost, if not altogether, to the oblong medulla, for in these creatures the nerves are proportionate to the size of the parts to be actuated by them, and are large beyond all comparison with that of the cerebellum. After the first and second, therefore, the origins of all the nerves must be attributed to the oblong medulla, it being allowed that they have their functions modified, according to the state of the cerebellum, the annular tubercle, and the brain, as well as of the oblong medulla.

The oblong medulla is the centre of the nervous system, to which a larger or smaller brain and cerebellum are added. It is necessary for the support of life in the four superior classes, and in a considerable degree corresponds with the dimensions of the trunk of the body and the size of the heart in each animal. In mammalia it is much larger, in proportion to the brain or cerebellum, than in man, also in birds, amphibia, and fishes; as an individual part, in mammalia and birds, it is larger and more complicated in proportion to the size and number of nerves originating from it and of the spinal marrow, than in amphibia and fishes.

If the functions of the oblong medulla had depended on tributary powers from the brain, its connecting parts, the crura, would have corresponded with the proportions of the brain, and not with those of the oblong medulla; they would have been larger in man than in the horse, and in a similar degree in other creatures; they are, however, much less: it is probable, therefore, that its magnitude exists primarily for giving origin to so many important nerves, and secondarily for affording a medium of communication between the animal portions of the brain and spinal marrow, but the precise uses of the several chords and prominences are not ascertained. The particular tracks of sensation and motion have not been determined. It is probable that the will is conducted by a different one from that of the sensitive impulses towards the sensorium; but whether it be necessary for these to be so distinct as to be capable of demonstration is very doubtful.

When nerves are absent, and the parts supposed to give origin to them are present, it may seem either that these are not the sources, or that they have been formed in vain; but, although nerves do not arise directly from them, their presence may contribute to the production of that universal and harmonious sensation, existing in every perfect being of the higher classes, so that without the parts from which the olfactory and optic nerves usually arise, not only the other faculties of the brain would be defective, but also those of the several organs of the body. The lost functions of nerves, and sometimes their wasting, as well as the parts giving origin to them, may in some degree invalidate this opinion.

The general structure of the brain consists of a delicate membrane, formed into cells, in which the medullary and cineritious matter are deposited. Its odour varies in different animals, the quality of its component parts also varies, and with this its greater or less quickness of perceptibility and other powers. A decided difference in its quality and conformation, in two species, is presumed to be unfavourable to reproduction.

For the determination of the particular faculties, each portion of the brain has been placed in a peculiar order, but has been so modified as to allow it either to act separately or in concert with others.

Although the similarity of the nervous system is usually the greatest in animals resembling each other the nearest, yet there are differences even in those of the same genus. Sometimes changes in the form of the brain take place for adapting it to the convenient shape of the skull, but others occur without any mechanical cause. It may be presumed that modified functions are generally the result of variations of structure, as different qualities exist in the nerves of the senses, each of which has a peculiar origin and construction.

It is difficult to determine the required size and elaboration of the medullary matter necessary for constituting a brain, or centre, for exciting sensations, and such motions as are agreeable to the animal, as in many of the lower animals there is very little difference between the brain and spinal ganglia. Only a small quantity of cerebral matter is necessary for giving the requisite power to the nerves, even in fishes and amphibia. But a very limited brain, if it be mature, ministers to the senses and the direction of the motive powers; other faculties require additional parts, until it attains to its greatest degree of complexity. The size of the brain, however, abstractedly considered, does not produce the various faculties, but the particular form and structure of its several parts, the supply and quality of the blood, and the action of the respiratory organs; for a larger brain of an amphibious animal has not the same powers as a smaller one of a mammiferous.

When the brain has been developed, as in man, the nerves are not proportioned to it as a whole, but principally to the oblong and spinal medulla, and the parts ministering to the senses. The intellect generally corresponds in degree with the size of the hemispheres, but cannot be evolved, unless these are properly connected with other portions of the brain, the completion of whose functions is dependent upon the perfection of their nerves, whilst that of the nerves is equally so upon the development of the parts of the body on which they respectively terminate. It is through the nerves, and their conjunctions with each other, that an harmonious co-operation takes place between the various organs of the body, the spinal marrow, and the animal parts of brain, common to the four superior classes, and through fibres and processes, that of the animal parts with the intellectual.

When the different portions of the brain, or the organs on which the nerves terminate, have been deficient at birth, or when these have been perfect, and the functions of the brain impeded by diseases, the intellect either has not been developed, or has ceased to be manifested. Although each part of the nervous system, belonging to or connected with the brain, possesses some inherent quality for the completion of its functions, it must generally be combined with others; and whether the exhibition of one or more faculties be required, the several parts concerned in their production must be excited and controlled by a sentient immaterial power.

The intellect appears to have larger powers in proportion to the extent of some parts of the brain. Perceptions may be received by it with a quickness, corresponding with the development of the particular track by which they are conveyed. Its powers may be also clearer in a healthy creature, on account of the free action and functions of all the organs concerned in the depuration of the blood, as the supply of this, in too great a quantity, or of an improper quality, encumbers the medullary matter composing the different tracks, and prevents it from receiving or conveying impressions in a manner necessary for harmonising with the accustomed state of the intellectual faculties. Inflammation, and other diseases, by altering the cellular tissue, containing the medullary matter, may produce a similar embarrassment. In mammalia and birds, the energies can be much longer preserved in exercise than in amphibia, which have a smaller brain in proportion to several parts of the body, and less distinct circulating and respiratory organs and functions; but when either the organs of respiration or circulation, in mammalia and birds, fail or become diseased, their link is broken, and states resembling those of the lower classes are produced, but which are not so harmonious in their results as in these, the parts, although inferior, have to be adapted to the sustenance of nervous centres, corresponding to their lower degree of action and elaboration; they have also less perfectly oxygenized blood, and consume little food: the higher classes, therefore, when labouring under disorders impairing the circulation and respiration, may, with advantage, adopt a similar abstinence; but as the exercise of the brain only in man may occasion a greater demand for nourishment, this organ ought to be kept as passive as possible, that whilst the circulation is brought to resemble that of the lower classes, the brain may be accommodated to a corresponding change.

Independently of the circulation of the blood, and its changes produced by respiration, and the diseases connected with over-feeding, and an original peculiarity of structure in animals, the brain is much less liable to disorders than it is in man, on account of the absence of the mind.

After the observations already offered, respecting the formation and general adaptation of the nervous system, to variously constructed bodies, and its particular arrangement in each class of animals, it may appear necessary that some consideration should be given to the connection of the intellectual faculties with the material organs in man. For the sake of avoiding as much as possible circumlocution, the soul, or spiritual part of man, and the mind, the intellectual part and index of its state in the healthy condition of the body, will be considered as united and forming the immaterial being.

It has been stated that the basis of the nervous system is the nervous element modified by the different substances of the brain, the spinal marrow, and the ganglions; it must, however, approach to the nature of the immaterial being, as it forms the link which unites this with the material organs, and through these with the material world, every part being duly sustained by the vital influence of the blood. But some portions of the nervous system minister to its power in a much greater degree than others, and particularly the convolutions of the brain, these are proportionate with the intellectual faculties, to which they give them a wider or more limited range, according to their development; they do not, however, form any part of the immaterial being, but are the mere instruments for its use and power, and necessary for its improvement and enlargement, for it remains mute and passive, exalted or debased, according to its neglect or cultivation, or improper use through these means. Besides the special influence admitted from the senses, it can, for particular purposes, through the material organs, call into action various parts of the body, and render these subservient to its power, in a manner unattainable by similar ones in animals, which are incapable of being raised above their natural state, except in a very slight degree. Animals appreciate perceptions by the very limited power of instinct, which is the measure or capability of intelligence implanted in each of them, according to the design of Omnipotence, and necessary for directing their appropriate energies; and for the carrying out of this plan, the nervous system has been so arranged as to vary with the required station of every creature, and the organs of which its body has been necessarily constructed.

The brain is the medium through which the mechanical forms, admitted by the eye, are conducted, as well as the different forms of the air in sounds by the ear, and the influence of the organs of the other senses; but the power of comparing and arranging these impressions in thinking, is independent of the material organs, and is an operation of the mind. But although the mind may seem to have been produced, it has only been instructed, and had its powers made apparent through the healthy brain, receiving impressions from without, and imparting others by the nerves to various organs of the body, and producing speech, writing, and other accomplishments.

The manifestation of the immaterial being is intercepted naturally by sleep, its connection with the material organs may be interrupted by a mechanical or a mental shock, both of which may disarrange the functions of the brain; by destroying the nervous element through poisons; by impeding, for a longer or shorter period, the circulation or the salutary changes of the blood; also, by organic læsions of the brain, or spinal marrow, and their membranes and blood-vessels. The mind may seem to be annihilated by apoplexy, or to be perverted in madness, but these are only defects of manifestation arising from a derangement of the parts of the brain forming the medium of communication between the immaterial being and the material world; it is possible, however, that the mind may be primarily disordered, and involve secondarily the material organs.

After the extinction of the nervous element at death, the immaterial being, or that termed animus by Cicero, still lives, but ceases to will or receive impressions through the material organs. "Mihi quidem nunquam persuaderi potuit, animos, dum in corporibus essent mortalibus, vivere; cùm exissent ex iis emori: nec verò tum animum esse insipientem, cùm ex insipienti corpore evasisset; sed cùm omni admixtione corporis liberatus, purus et integer esse cœpisset, tum esse sapientem."

The origin of the olfactory nerve varies in different kinds of animals; in the monkey and baboon, it is very similar to that in man, but in the horse, sheep, dog and others, it occupies a very considerable space at the base of the brain, and is connected with the inferior portion of the hippocampus. It terminates in a bulb composed principally of cineritious matter placed over the cribriform plate of the ethmoid bone; and through perforations of this, numerous branches pass to the nose, where they become more or less combined with branches of the fifth; the branches of one portion, after an expansion on the membrane covering the plates of the ethmoid bone, converge and become connected with a branch of the lateral nasal nerve, and then separate to be distributed on the membrane covering the turbinated bones and the rest of the exterior walls of the nose; the other portion is continued upon the membrane expanded on the septum; the branches of the nerves, soon after their entrance into the nose, become impacted in the membrane. This mode of distribution is well seen in the horse.

The optic nerve in mammalia is very similar to that in man. The tract is a continuation from the thalamus; it is connected with the surrounding parts, as the surface of the nates, the geniculate body, the crus of the brain, the mammillary eminence and the part surrounding this, but it is difficult to define the precise limits of its origin; the commissure is not generally so large as in man, therefore each nerve passes more directly to its foramen, and is longer or shorter in different animals according to the nearer or more distant position of the eye; it becomes expanded into a soft retina similar to that in man.

In mammalia, the third nerve arises from the inner side of the crus of the brain, as in man; it passes into the orbit and supplies all the muscles except the superior oblique, the abducent and retractor. It sends a branch to be joined by one from the fifth in the ciliary ganglion; from which, in the monkey, branches similar to those in man proceed to the interior of the eye; but in many other animals the ganglion is by no means proportionate to the size of this organ, and sends off only a few thick branches; more branches of the fifth, however, appear to terminate on the eye-lids and the conjunctive membrane. In the jaguar, there is a ganglion on the portion of the third, which eventually terminates in the inferior oblique muscle; it sends a branch to pass on the outer side of the optic nerve into the eye; it sends also a very large branch to be joined by a branch from the superior nasal, but not to form a ganglion, and from this junction branches pass along the inner side of the optic nerve into the eye ; the ciliary ganglion and nerves are larger in proportion to those of the ass and sheep, but the branches entering the eye are not so numerous as in man. In the pig, the third nerve supplies the usual muscles of the eye, and gives off some ciliary filaments. A branch of the third is then joined by a nerve formed of two branches ; one proceeding from the first trunk of the fifth, the other from the beginning of the second trunk, at a spot at which a branch of the sympathetic is received. After this union, it gives off ciliary filaments to pass along the optic nerve ; it is then directed to terminate in the inferior oblique muscle. The ciliary nerves are very insignificant, but numerous branches of the fifth supply the eyelids. In the calf, the branch of the fifth, joining the branch of the third in the ciliary ganglion, arises from the Gasserian ganglion near the first trunk of the fifth, at the part receiving the branches from the superior cervical ganglion of the sympathetic ; it appears to be a continuation of one of those branches of the sympathetic which also communicated with the sixth ; it passes into the orbit, and receives a branch from the third nerve to form the ciliary ganglion. It is very probable that the ciliary nerves are thus generally connected with the sympathetic, although the communicating branches cannot be easily detected. In the sheep and goat, the branch given to the lenticular ganglion arises from the Gasserian ; in the goat it is a very slender thread, but divides into two, one of which joins the lenticular ganglion, the other, one of the ciliary nerves arising from this. In the dog, the branch joining that of the third nerve in the lenticular ganglion proceeds from the superior nasal.

The fourth nerve, as in man, arises behind the quadrigeminal bodies from the superior pedicle of the cerebellum, near the roof of the passage from the third to the fourth ventricle. It terminates on the superior oblique muscle of the eye.

The fifth nerve arises from the crus of the cerebellum and the annular tubercle ; in the horse its origin is easily traced downwards to the termination of the oblong medulla, where it forms a conical prominence ; the smaller portion is on the inner side, and appears to arise near the junction of the crus of the cerebellum with the annular tubercle. With the exception of those of the smaller portion, its fibrils undergo a change of arrangement in the Gasserian ganglion, and become formed into three trunks, the smaller portion passing with the third. In many animals, as the horse, ass, calf, and goat, the fibrils, forming its trunks, and particularly the second, are very coarse ; but not in others, as the dog, baboon, and monkey. It appears to communicate with the sympathetic, particularly at the Gasserian ganglion.

The first trunk differs very little from that in man. In the calf the branch of the superior nasal passes through a foramen to the superior part of the cribriform plate, but continues to be covered by the dura mater lining this, to which it gives filaments; two principal branches enter the nose, one passes on the Schneiderian membrane of the septum, and may be traced near to the extremity of the nose, the other passes on the Schneiderian membrane, at the superior part of the outer surface of the nose, and at about one-third of the distance from the upper part of the nose sends a branch outwardly, underneath the nasal bone, to the strong membrane covering the Schneiderian membrane, it then passes to the extremity of the nose, and terminates on the Schneiderian membrane, and the strong membrane covering this. The continuation of the superior nasal forwards, after it has sent the large branch into the nose, appears to occupy the place both of the superior nasal and supra-orbital, by its supplying so considerable a part of the upper eye-lid and eye-brow with branches. In the dog it gives off the superior nasal, this sends one branch into the nose, and then passes to the inner angle of the eye, to terminate on the upper eye-lid and eye-brow; it gives off another that may be compared with the supra-orbital in man, which gives a branch to join, one from the temporal, for the lachrymal gland, and then supplies the middle of the upper eye-lid and eye-brow. There are variations in different species, so that the nasal may send off a considerable branch to the middle of the eye-lid and eye-brow, just before it leaves the orbit, or this branch may be sent off at the beginning of the first trunk, and then resemble more the supra-orbital in man. In the pig it gives off the superior nasal, which sends one branch into the nose, and then passes to the inner angle of the eye, to terminate on the eye-lid and eye-brow: it gives off another, that may be compared with the supra-orbital in man, which communicates with the lachrymal nerve, and then supplies the middle of the upper eye-lid and eye-brow; it gives off the lachrymal, which sends filaments, with others from the temporal to the lachrymal gland, and then supplies the outer part of the upper eye-lid. In the sheep minute filaments from the supra-orbital nerve, enter the sclerotic coat of the eye; a small branch gives filaments to the lavator muscle of the eye, and then joins the fourth nerve, before its termination in the superior oblique muscle; filaments also pass to the other muscles of the eye, the fat and conjunctive membrane of the eye-lids.

The second trunk of the fifth is usually very thick; it gives off the malar nerve, which divides into a temporal and malar branch, as in the dog, but varies in size in different animals, according to the extent of the parts to be supplied; in the dog the temporal branch of the malar gives a branch to communicate with one from the supra-orbital for the lachrymal gland, and then passes out at the exterior of the orbit, communicates with a branch of the hard portion, and is distributed to the cutaneous muscle and skin of the temple. The malar branch, on emerging from its foramen, communicates with a branch of the hard portion, and then terminates on the skin of the face and the lower eye-lid. In the calf, pig, and sheep, the temporal and malar branches arise separately. In the calf a nerve is sent from the Gasserian ganglion, close to and communicating with the temporal; it supplies the lachrymal gland, and then terminates on the outer part of the upper eye-lid and eye-brow; the temporal emerges at the exterior of the orbit, communicates with the hard portion, and gives branches to the superficial muscles and skin of the temple; the greatest part of it then passes outwards, to be distributed on the horn. The malar portion, on emerging, communicates with the hard portion, and is distributed principally on the lower eye-lid. Two other branches from the Gasserian ganglion pass outwardly in a canal on the inner plate of the frontal sinus, as far as the junction of this with the outer plate, near the insertion of the horn. In the pig the temporal sends off filaments, which communicate with others from the outer branch of the lachrymal, and then passes on the temple, and joins a large branch of the temporal branch of the hard portion, to supply the outer part of the orbicular muscle and the skin of the temple; the malar emerges from the orbit, and communicates with a filament of the hard portion, and then supplies the lower eye-lid. In the monkey, the second trunk of the fifth gives off the Vidian, the lateral nasal and palatine as in man, but not from a ganglion. In many other animals the second trunk gives off the lateral nasal and palatine, which sometimes arise in one branch, and then separate; the lateral nasal becomes connected with the Vidian, and on entering the nose becomes also connected with part of the olfactory, and is distributed on the Schneiderian membrane; the palatine passes through one or several foramina, to be distributed on the palate. In the calf, the lateral nasal and palatine nerves arise separately, but communicate afterwards by several branches at the posterior part of the nose and palate, before they pass to their respective destinations. The lateral nasal nerve, on entering the nose, divides into two portions, one sends filaments to the concentrated part of the olfactory nerve as in the horse, and divides into branches, to be distributed on the Schneiderian membrane, covering the turbinated bones, and the rest of the exterior surface of the nose; the branches pass between this membrane and the periosteum; the other passes to the Schneiderian membrane, covering the septum on which it is chiefly distributed; a branch passes forward, and at about one-third of the distance from the extremity of the nose, escapes through the palate bone, and is continued on the middle of the palate, to terminate at the anterior extremity of this part. Three bundles of small branches of the palatine nerves pass to the posterior portion of the palate, the large part of the nerve then passes through the large foramen, and divides into several branches, which proceed to the middle and anterior portions of the palate, and distribute filaments in their course. In the jaguar, a fine branch and a large one, from the second trunk, supply the teeth of the upper jaw, filaments of both pass through perforations of the bone to the double teeth, the rest of the large branch then supplies the large pointed tooth, passes round the fang of this, and descends to the fang of the first incisor, and winds round this to supply the other two. In the calf, six or seven branches pass very obliquely forwards, so that they ramify on the capsules of the pulps, and enter the teeth at a distance from their origin, some of them communicate before their termination. After supplying the teeth, the continuation of the trunk, in various animals, emerges beneath the orbit, at one, two, or three foramina, at different distances from the orbit, carefully defended against injury by the prominence of the inferior margin of the orbit, or when it emerges lower down by a ridge of bone; and although its exit by several foramina is constant in the baboon, it is in some also accidental, and in the calf not unfrequently occupies a single opening on one side, and two on the other; its usual distribution is, however, nearly the same; it gives branches to the levator muscle of the upper lip in the calf, but in the pig the branches pass through the fibres of the long muscle of the snout to the skin; it then divides into numerous branches, which communicate generally with branches from the hard portion of the seventh, and terminate on the muscles and skin of the upper lip and the exterior of the nose, whilst a few pass to the interior of this organ. In the pig some filaments of the hard portion communicate with several branches of this trunk, just before they terminate on the upper lip and snout.

The branches of the third trunk of the fifth differ very little from these in man, except that they are larger or smaller according to the varying size of the parts furnished by them. The nerve given to the circumflex muscle of the palate is generally very slender. The deep temporal supplying the temporal and masseter muscles, are large in proportion to the branches sent to the pterygoid muscles in the jaguar. There is some difficulty in making comparisons relating to the size of the nerves of different animals, as they are composed of finer and closer fibrils in carnivorous animals than in herbivorous, and have not an equal bulk in proportion to the same extent of parts receiving them.

The superficial temporal nerve in the calf passes behind the ramus of the jaw; it sends a large branch forward to join the middle branch of the hard portion of the seventh; it sends a large auricular branch backwards, one part of which passes to the inner surface of the concha of the ear; the other communicates with a branch of the hard portion passing to the muscles of the external ear, and then terminates on the skin near the margin of the concha. The branch of this nerve passing to the face is large in the horse and less in the calf; it becomes united with a large branch of the hard portion in the face of both these animals, but with a mere filament in the sheep; the auricular branch varies very much with the size of the external ear. In the calf, the trunk, before dividing into the gustatory and inferior dental nerves, gives a branch to the internal pterygoid muscle; others are given to this muscle by the otic ganglion. The gustatory nerve exists only in mammalia, it receives the chord of the tympanum, it passes between the external and internal pterygoid muscles, next underneath the membrane lining the mouth, and then between the lingual muscle and the insertion of the genio-hyoideal, and divides into branches; some of which communicate with others of the ninth, and pass upwards to terminate in the papillæ at the anterior and middle portions of the surface of the tongue; it gives branches also to the salivary glands, and a considerable one to be distributed on the portion of the membrane of the mouth connecting the side of the tongue with the lower jaw. In some animals, as in man, it is difficult to determine whether the branches do not give filaments to the muscles in passing to the surface of the tongue. The gustatory nerve is rather larger in proportion to the size of the tongue in man than in the baboon, and in this than in the sheep, goat, calf, and ass; and in these than in the dog, and in this than in the jaguar. The coarseness of the texture of the fibrils is, however, generally in the reverse order, except in man and the baboon, it being the greatest in the sheep, goat, calf, and ass, and least in the dog and jaguar. The chord of the tympanum is almost peculiar to mammalia; a resemblance of it has been traced in birds. In the calf, it begins at the hard portion, and passes across the membrane of the tympanum nearly as in man; it communicates with the tympanine nerve of the glosso-pharyngeal, and the sympathetic on the outside of the petrous portion forming one surface of the tympanum; it passes downwards, and at length becomes intimately united with about an inch of the gustatory nerve; a nerve is again given off from the side at which the chord of the tympanum joined the gustatory; this communicates with two other branches, and is then distributed on the posterior part of the surface of the tongue; by dividing communicating filaments this might be made into a continuation of the chord of the tympanum; but it would be a deception. In the ass, it is in apposition with the gustatory nerve for a short distance, and then becomes intermixed with fibrils of this nerve. In the dog, it becomes intimately conjoined with the gustatory. In the goat, it forms a distinct oval ganglion close to the tympanum, which sends filaments into this, and then descends and joins the gustatory nerve, with the fibres of which it coalesces.

The inferior dental nerve, just before entering the lower jaw, gives off the mylo-hyoideal nerve which descends, closely connected with the periosteum lining the inner surface of the jaw, until it reaches the inferior belly of the digastric muscle. It is larger in carnivorous than in herbivorous animals ; it supplies the inferior belly of the digastric and the mylo-hyoideal muscle only in man and some animals, as the baboon, pig, and sheep, whilst in the dog and fox, it sends branches to the face to join some from the hard portion of the seventh, and others forward to the cutaneous muscle underneath the jaw ; on the right side of the face of a dog, two branches joined the hard portion, and on the left only one ; whilst a branch was given by the hard portion to the inferior belly of the digastric muscle ; in the pig, it sends a branch outwards to the salivary glands. The inferior dental nerve passes behind part of the internal pterygoid, and then part of the insertion of the external ; it enters the lower jaw, and gives branches to the teeth ; it usually emerges at a single foramen near the chin, when it immediately divides into two or three branches ; some of which communicate with filaments of the hard portion, and all of them, after ramifying, terminate on the muscles and skin of the lower lip. In the baboon, it sends branches through several foramina. In the pig, from near the angle of the mouth, it begins to send out four small branches from separate foramina ; the second entirely and immediately joins the large branch of the hard portion proceeding towards the chin, and the rest communicate with some of the branches of this nerve. The principal part of the inferior dental nerve then emerges from the foramen near the chin, and ramifies in the usual manner. The buccal nerve in the calf gives a branch to the external pterygoid muscle ; it then passes over the inner surface of this muscle ; it emerges from underneath the anterior edge of the masseter, and divides into branches, which terminate on the buccinator muscle and the skin of the face, and form considerable communications with branches of the hard portion. The buccal in a great measure supplies the cheek, or that triangular portion situated between the masseter muscle and the corner of the mouth, so that it is larger or smaller in different animals according to the extent of this part.

The sixth in the monkey arises from the posterior edge of the annular tubercle and the pyramidal body, nearly as in man ; and in the horse and sheep, from the trapezoid body in the groove corresponding with that continued downwards on the outer side of the pyramidal body. It communicates with the sympathetic in the monkey, dog, jaguar, pig, calf, and others; and in the calf also with the first trunk of the fifth. It terminates in the abducent muscle; also in the retractor when present.

The character, origin, and distribution of the auditory nerve are nearly the same as in man. It arises from the side of the fourth ventricle and the restiform body, and has some connection with the crus of the cerebellum. It communicates with the hard portion in the internal auditory meatus; after its division one portion passes to the base of the cochlea, and sends branches through perforations in the modiolus to the spiral lamina, on which it forms a more fibrous or thready retina than the optic nerve, whilst the rest terminates in the vestibule and the semicircular canals.

In the baboon and monkey the trapezoid body is so small that the origin of the hard portion appears nearly like that in man, but in other animals this nerve usually arises from the trapezoid and restiform bodies. It communicates with the vestibular division of the soft portion in the internal auditory meatus in the calf; after it has left this, it receives the chord of the tympanum, and sends a branch to join the trunk of the par vagum, but it does not receive a branch of the Vidian nerve as in man and the monkey; this deficiency may, however, be supplied by the filaments of the sympathetic, which pass on the outer surface of the labyrinth. The branch sent to the par vagum in the goat, forms a ganglion at the point of union with this nerve. After it has escaped from its foramen, it is large and of a different size in various animals; in the baboon and monkey its distribution is very similar to that in man, but the branches are smaller; it gives a branch to the superior belly of the digastric muscle, and to a slender one like the stylo-hyoideal in the baboon and dog. In the dog it sends a branch to pierce the cartilaginous portion of the tube of the external auditory meatus, and terminates on the skin. It gives branches to communicate with others of the first cervical nerve, to terminate on the cutaneous muscle of the neck and skin of the auricle. It gives off a branch which becomes connected with the superficial temporal branch of the third trunk of the fifth, to be distributed on the muscles of the external ear. It then divides into three principal branches, the temporal passes over the eyebrow to the cutaneous muscle of the forehead and nose, gives filaments to the orbicular muscle of the eye-lids, and communicates with the temporal and malar branches of the malar and supra-orbital nerves. The middle branch passes towards the upper jaw, and communicates with branches of the buccal nerve and the second trunk of the fifth, and terminates on the muscles of the middle portion of the face and the upper lip; the inferior branch extends towards the lower jaw, communicates with the buccal and the mylo-hyoideal branch of the inferior dental, and then communicates with branches of the inferior maxillary nerve on the chin, and gives branches to the muscles of the face and lower lip. In the pig, after giving branches to the salivary glands and surrounding parts, it divides into three principal branches: the temporal is the smallest; one part of it passes over the eye-brow, the other communicates with the auricular branch of the third trunk of the fifth, and supplies the more anterior muscles of the external ear; it sends also a large branch backwards to the more posterior muscles of this part. The inferior branch passes quite behind the angle of the lower jaw, and mounts up into the face, along with the facial artery, just beyond the anterior insertion of the masseter muscle; it sends a branch forward along the lower jaw to communicate with branches of the inferior dental nerve, to be distributed on the face and lower lip; it then joins the middle branch, where there is an intimate connection between this junction and part of the buccal, passing towards the angle of the mouth; it gives branches to the muscles of the lips and mouth, and supplies the large muscles of the snout, as well as the smaller ones connected with the skin of this part. In different animals, the several branches are larger or smaller, according to the extent of the parts supplied; the ramifications of these also vary with the form and direction of the muscles. The temporal branch in the baboon and monkey is small, also in the sheep, but in the calf it is large, and still larger in the dog. There are differences also with respect to its degree of communication with the branches of the fifth; in the sheep, both pass nearly separate to their destination: the final distribution of the branches arising from both is not, however, in consequence much altered.

The glosso-pharyngeal nerve arises from the restiform body; it passes out of the head with the trunk of the par vagum. It then forms a distinct ganglion in the dog; in the goat and calf, it has a slight change in texture; but in the ass, sheep, and jaguar, it has not any discernible difference; it, however, varies in this respect in different instances of the same animal. It soon gives off the tympanine nerve, which is usually large when compared with that in man; it may be seen ramifying in considerable branches on the external surface of the labyrinth, particularly in the horse, calf, and sheep, and communicating there with branches of the sympathetic, and the chord of the tympanum. It communicates with the superior cervical ganglion of the sympathetic. In the ass, it adheres to and gives filaments to the membraneous pouch connected with the posterior part of the fauces. It supplies the stylo-pharyngeal muscle and the pharynx, and becomes connected with the pharyngeal plexus, which is much less intricate in animals than in man. It then passes forwards, distributing branches to the tonsils and membrane between the epiglottis and tongue, and terminates on the posterior part of the surface of the tongue. The variation in the proportion of the glosso-pharyngeal nerve to the tongue is not generally very remarkable in different animals, but in the jaguar only one small branch was traced to the membrane on the outer edge of the posterior part of the tongue.

The par vagum arises from the restiform body. In the calf, goat, and ass, it soon sends off a branch to join the hard portion. In the jaguar, dog, pig, and rabbit, there is a ganglion near the place at which the superior laryngeal nerve arises. In many others, as the monkey, calf, ass, and Cashmere goat, there is an intricate disposition of some of the fibrils of the nerve about the origin of the superior laryngeal, but not a distinct fleshy ganglion. A nerve is not in all animals fit for its destination just after leaving the brain, but in many instances requires to have some change effected in the disposition of its fibrils, and particularly at the departure of its branches, and this change may be effected by a fleshy ganglion in some instances, and a thready interchange of fibrils in others, either of which disposition becomes a modified but similar means for suiting the peculiarities of each animal. In the pig, the superior laryngeal nerve gives a branch to the pharynx and the crico-thyroideal muscle, and terminates on the membrane of the glottis, the epiglottis, and the superior part of the larynx, and communicates with branches of the recurrent, after which this nerve terminates on the muscles of the glottis. In the jaguar, the enlargement is situated much lower down than in the pig and other animals; the larynx is also placed lower in the same degree; the laryngeal nerve arising from it gives branches to the pharynx and crico-thyroideal muscle, before it passes to the glottis. The course of the par vagum through the neck is very similar to that in man; but in many instances, as the calf, sheep, dog, and jaguar, the prolongation of the sympathetic from the first cervical ganglion adheres to it, and in the calf forms communications with it; but in the rabbit, hedge-hog, and others, the sympathetic is generally separate from it: it is so in some species of the baboon and monkey, if a partial adhesion a little below the superior cervical ganglion be excepted. In the jaguar, after the sympathetic has left the right trunk at the bottom of the neck, it communicates with the inferior cervical and first thoracic ganglia, and gives off some branches to the heart, and sends the recurrent round the subclavian artery, which, as well as that on the left side, communicates very much with the cardiac nerves before it passes up to the larynx; the trunk then gives filaments to the trachea, and passes to the back of the lungs, where it gives off the pulmonary plexus, which communicates with the thoracic plexus as in man; it then sends off a branch to be joined by one from the left trunk to form the anterior chord which gives filaments to the lungs, and one to the right auricle, and the termination of the inferior vena cava; it sends off a large branch to join the posterior chord; the anterior chord then passes through the diaphragm, and terminates on the anterior surface of the stomach; some of its branches communicating with branches of the sympathetic accompanying ramifications of the cœliac artery. The left trunk, after it has given off the sympathetic, sends the recurrent round the arch of the aorta to communicate very much with the cardiac nerves before it passes up to the larynx; the trunk gives off several cardiac branches, and a large branch to join the anterior chord; the rest of it is then joined by a large branch of the right trunk to form the posterior chord, and pass through the diaphragm to give branches to the cœliac plexus and to the broad extremity of the stomach, and then terminate by distributing branches on the posterior surface of the stomach. Although there be some variation in the size and number of the branches given off by the par vagum, they are very similar to those in the jaguar. After sending branches to the thoracic viscera, the two trunks do not separate into so many large branches as in man, but combine into two principal chords of unequal size; and although they do not form so intricate a plexus as in man, they give off numerous filaments, which cover the outer surface of the œsophagus, and are extended in some measure to the cellular membrane and the aorta; the smaller or anterior chord, after passing through the diaphragm, sends branches to the lesser omentum in the baboon, calf, and other animals, to form the left hepatic plexus; but in the dog, these pass almost immediately between two lobes of the liver on the left side for the same destination; the other branches of the anterior chord follow the anterior surface of the smaller curvature of the stomach, as in man, and communicate with branches of the right hepatic plexus. The larger or posterior chord, whether it forms one or two portions on the œsophagus, before it pierces the diaphragm, gives branches to the large extremity and posterior surface of the stomach; but a considerable part of it intermixes with the cœliac plexus, from which some of its branches may be traced to the beginning of the large intestines. In ruminating animals, both chords give branches to the supernumerary stomachs; but with the exception of their larger size, they are the same as in man and other animals. In one baboon, two branches of the right trunk were joined into one behind the œsophagus, and then combined with the portion of the left trunk to form the larger or posterior chord, but in another baboon, one of these branches from the right trunk joined the posterior chord to pass to the cœliac plexus and the stomach; the other descended separately also to pass to the cœliac plexus and stomach. In the ass, the anterior chord of the par vagum is very small; it gives some filaments to the stomach and others to pass on the small omentum to the liver, where they communicate with branches of the right hepatic plexus. A great portion of the posterior chord forms a thready expansion, part of which passes in branches to the stomach, and the rest to the cœliac plexus.

The cervical portion of the par vagum is rounder in the jaguar than in the ass, in which it is rather broader and flatter, so that there is not much difference in their size; it is nearly equal in the jaguar and baboon; in these it is a little less than in the dog, and less in the dog than in the pig. The anterior chord on the œsophagus, just before it passes through the diaphragm, is nearly of the same size in a young ass, about a month old, and one a year older; but the posterior is somewhat larger in the older. The anterior chord is rather less in the ass than in the baboon and jaguar, in both of which it is equal; it is less in the jaguar than in the dog, and less in the dog than in the pig. The posterior chord is less in the baboon than in the ass and jaguar, less in these than in the dog, and less in the dog than in the pig. The cervical portion was larger in the calf a week old, than in the ass a month old; the anterior and posterior chords, after supplying the lungs, were both also much larger in the calf, but this was before the ruminating stomachs had been much used.

In mammalia, the pharyngeal plexus is very much like that in man, but not near so complicated. In the ass, a branch is given from the glosso-pharyngeal, and from the union of the par vagum and accessory, and from the superior cervical ganglion of the sympathetic; these communicate and terminate on the pharynx. In the ass, some filaments, from the prolongation of the sympathetic, after its connection with the trunk of the par vagum, are also given to the pharynx. In the dog, a communication takes place between the ninth, the accessory, the par vagum, and the glosso-pharyngeal, and from this and the superior cervical ganglion of the sympathetic, and the descending portion of the ninth, branches are given to form the pharyngeal plexus; the superior laryngeal nerve is given off by itself, a little below this, from the ganglion of the par vagum, and sends a branch to the crico-thyroideal muscle. In the jaguar, the pharyngeal plexus is formed from the glosso-pharyngeal, the conjoined par vagum and accessory, and filaments from the superior cervical gangion of the sympathetic; the lower part of the pharynx also receives branches from the superior laryngeal nerve. In the pig, the pharyngeal plexus is formed of a branch of the glosso-pharyngeal nerve, a broad expansion from the conjoined par vagum and accessory, and a branch from the superior cervical ganglion of the sympathetic. Some variation exists in the formation of this plexus, on account of the difference of the par vagum and the connection between this and the sympathetic; it terminates principally in branches on the pharynx ; it sends some on the branches of the carotid artery to supply their coats; also to the salivary glands, but these sometimes rather appear as if they proceeded from the superior cervical ganglion of the sympathetic, and only communicated with this plexus.

The ninth arises from the oblong medulla, at the side of the pyramidal body; it passes out, in two or three bundles, which unite, and then communicate more or less with the trunk of the par vagum and the sympathetic; in the ass, there is not a communication with the par vagum as in man, but there is with the superior cervical ganglion of the sympathetic; in the calf, there is not a communication with the par vagum. In the jaguar, the ninth is large in proportion to the size of the gustatory nerve, as well as of the tongue; probably the difference arises from the great length of the muscles passing from the hyoid bone and lower jaw to the tongue; in the pig, as well as in the jaguar, it becomes strongly united with the par vagum and accessory; but it appears to be principally, if not altogether, by dense cellular membrane. The descending branch, except in the baboon and monkey, is usually more slender than in man; in the jaguar, there are three slender branches, one for the sterno-hyoideal muscle, another for the thyro-hyoideal, and the third, which is joined by the anterior trunk of the sub-occipital, to terminate on the sterno-hyoideal and sterno-thyroideal muscles; the sub-occipital, in passing down, forms a broad membranous attachment to the ganglion of the par vagum. In the monkey, the descending branch combines with the anterior trunk of the sub-occipital and the first and second cervical nerves, for the muscles connected with the hyoid bone and thyroid cartilage; the same disposition occurs in the baboon, except that the branch of the sub-occipital rather joins the first cervical nerve, which at this spot gives off its branch to pass with the descending branch of the ninth, and the one from the second cervical nerve. In the fox, the descending branch is very small, being a mere filament it is joined by the anterior trunk of the sub-occipital. The ninth afterwards supplies the stylo-glossal and genio-hyoideal muscles, and then, as in the pig particularly, spreads out into a fan-like plexus or retina, and passing between the two planes of the genio-hyo-glossal muscle, supplies this and the lingual, and the delicately pectinated muscular structure forming the surface of the tongue.

The accessory nerve arises, as in man, principally from the spinal marrow, but has some fibrils from the oblong medulla near the origin of the par vagum; it arises also from the posterior bundles of several cervical nerves. It passes out near the par vagum; and in the goat, ass, pig, and jaguar, becomes united with this nerve; and from both, filaments pass to form a chord to join the pharyngeal plexus. In the fox, it joins the glosso-pharyngeal, the trunk of the par vagum, the ninth and sympathetic; it enters the sterno-mastoid muscle, to which it gives branches; it then communicates with the union of the anterior trunks of the first and second cervical nerves, and with a branch of the third and one of the fourth, and terminates in the trapezius muscle. In the ass, it gives a large branch to the sterno-mastoid muscle, it communicates with the first and second cervical nerves and terminates in the trapezius muscle.

Although it has been beneficently ordained that the senses should be a source of some gratification, yet they exist, in a considerable degree, for satisfying the cravings of nature, and preventing danger to the person. The sense of smelling is formed for avoiding noxious substances, as much as for choosing things that are agreeable to the taste. It is presumed that odours pleasant to some animals are either very little perceived, or altogether avoided by others, and that their exquisiteness is not in proportion to the size of the nerve, nor to that of the parts of the brain giving origin to it, but to the development of the hemispheres and the peculiarity of the cerebral matter. The nose is the measure of odours that can be borne by the particular brain, as the eye is of light, and the labyrinth of the ear of sounds; for if the nose were more capacious in man, the sensitiveness of the nerves, exalted by the largeness of the brain, would overpower this organ, as it does in morbid conditions of the body. It, however, varies to answer particular necessities. In some fishes, the olfactory nerve is in an inverse proportion to that of the optic; it is so in some of the mammalia, but its size corresponds, in a great degree, with the provision made for collecting food; in the baboon and monkey, it is as small as in man, not altogether because the brain is so much larger in proportion to the body than it is in many other animals, but because they are furnished with hands for collecting their food, the quality of which may be in a great measure judged of by the eyes, whilst in animals not having such appliances, these nerves are continually warning them of the fitness of what they are gathering, and without such means a sufficient supply would not be obtained, especially of herbs, or it would be so intermixed with noxious particles as to be injurious, if not destructive of life: others, however, feeding on flesh, have the nerves large, almost entirely for guiding them to their prey; such assistance is indeed necessary for a comparatively short time; but in these creatures, whose nervous system is so excitable, and particularly during hunger, it could not have been continued very long with impunity.

Although the olfactory nerve has different roots, which, in many animals, are very extensive, it is probable that the perceptibility of the whole is nearly equal, and that there is not a filament for appreciating each odour; there nevertheless may be some variation, according to the origin of different portions. The sense may be perfected either through air or water, but it is difficult to determine in what way the odour is combined with these.

If the sense of taste were nearly as multifarious and exquisite in animals as in man, they could not be supplied with food, and if many, and particularly the graminivorous, had to seek theirs by taste or sight, they never could obtain a sufficient quantity for their being fattened, but whilst feeding, the odours snuffed in at each inspiration warn them of any deleterious qualities in the herbs, which the sight could only judge of by experience; and for this reason the olfactory nerves resemble so nearly the unaltered cerebral matter, as to determine at once the salutary nature of the aliment, and the approach of its elementary qualities to those of the body generally, and a repugnance to such as is either prejudicial or not agreeable.

If the sense of smelling be not so exquisite in all animals, the other parts usually sympathising with it are not so easily deranged. The digestive organs may not be furnished with nerves proceeding from a brain having the most exalted essential qualities, and therefore a nerve with a stronger perception is well adapted for ministering to its functions.

It may be a question, whether the branches of the fifth increase the power of the olfactory nerve, or in any manner modify the sense. They promote the functions of the Schneiderian membrane by endowing it with common sensation, and connecting it with other parts for opening the nostril and favouring respiratory actions; they perceive the presence of irritating but inodorous substances, in the same manner as the lining membrane of the cheek and the surface of the tongue do heat, cold, or pungent substances; they also perceive the presence of extraneous matters, and particularly hardened mucus, and thus prevent any obstruction to the free passage of the air to the lungs.

When the olfactory nerves do not exist, it is conceived that limited perceptions are experienced by common sentient nerves spread on membranes, as the inodorous, but pungent, vapours or fluids are, by the branches of the fifth, distributed on the Schneiderian membrane, or on that lining the mouth, or by the par vagum in the lungs and gills, producing a peculiar and apposite sensation, although not exactly that of smelling of the higher classes.

Vision, as far as it relates to the quality of light, the bulk, and the nearness and distance of objects, may be acute, according to the mechanism of the eye and the size of the optic nerve, the arrangement in the commissure, the supply of blood, and the structure of the ciliary ganglia and nerves; but the manner in which it is appreciable by the intellect may depend upon the mode of connection with, as well as the quality of the brain, and the extent of the hemispheres. It seems, therefore, to be agreeable to reason, that the optic tract should have extensive communications with the thalamus, and other parts, for the nerve is required to transmit images to, and have impressions or commands from, the mind, conveyed instantly to various parts of the body, and these actions are enhanced by the greater development of the brain in each class of animals. Some filaments from the lenticular ganglion, and the superior nasal nerve, become connected with the optic nerve; it is, however, a question, whether this communication does more than associate it with the membrane or tunic on which it is spread, and control its blood-vessels.

From the situation of the lenticular ganglion in the branch of the third nerve given to the inferior oblique muscle in the jaguar, and from the consideration of its being only indirectly connected with a branch of the superior nasal nerve, it may be presumed that the ganglion is placed there for the purpose of giving some additional properties to this branch of the third nerve; so that, if the ganglion does not minister directly and solely to the functions of the iris, it may, upon emergencies, through the inferior oblique muscle, involuntarily guard the interior of the eye, when the iris, by its contraction, or the admission of intense light, cannot sufficiently accomplish this purpose. As this ganglion varies both in size and situation when present, so the difference, thus produced in the nerves connected with it, qualifies the organ for some of its uses, according to the required condition of the animal. The lenticular ganglion of many animals, compared with that in man, is very small; but the eye-lids and conjunctive membrane have a copious supply of branches from the fifth; by the increased perceptibility of the appendages, the eye itself may be more securely guarded, but through the difference of the ciliary nerves have a subordinate power of vision. For further information see the author's *Treatise on Diseases and Injuries of the Nerves,* page 262.

The muscles of the eye in the four superior classes of animals have generally the same distinct nerves, but it is not clear why they have separate origins, unless it be for producing a greater independence of action of the muscles for the co-operative powers possessed by the two eyes, for the third nerve supplies two opposing muscles in the same eye as the levator and depressor, and the two levators acting in concert; it supplies the inferior oblique muscle opposed by the muscle of the fourth nerve, and the adducent opposed by the abducent muscle of the sixth. When a small object is to be observed, the nerve employed in the same action is principally that exciting the adducent of each eye; when a wide and extensive field is to be viewed, each abducent; but when objects are to be viewed laterally, as in reading, a different set of muscles and nerves in each eye is engaged for the same direction. In man, many of these motions are acquired by experience, whilst those in several animals are principally performed through the inherent power of the part of the brain giving origin to the nerves.

The fourth is a very remarkable nerve, both as to its origin, slender form, and extended course. In man, it is connected with the lachrymal nerve, and with a branch of the superior nasal for the lachrymal sack. It is in itself a voluntary nerve, but the flow of tears may stimulate it to involuntary action for moistening the conjunctive membrane.

As the muscles drawing the eye inwards have considerable power, it seems necessary that there should be a strong countervailing influence, which is provided for in the abducent muscle supplied by the sixth nerve; this, however, in many animals furnishes also the retractor muscle. As it does not appear to afford any particular qualities for the formation of the sympathetic nerve, it is not very evident why it joins this more particularly than the other nerves of the orbit. This communication may, however, associate the eye in involuntary actions with several organs, as in speaking, singing, hearing, or rotating the head. It may also regulate the supply of blood to the eye and brain during the act of speaking and singing, and be connected with various operations of other parts through the sympathetic. In the calf, sheep, and other animals, the branch appears to be rather passing from the sympathetic to the sixth nerve; this, however, as well as other conjunctions, may answer similar purposes to those in man.

The functions of the large portion of the fifth nerve become assimilated by the intermixture of its fibrils in a ganglion. The branches issuing from this supply the bone and teeth, the membrane covering the mouth and tongue, also the organs of the senses, and the skin belonging to their appendages, as well as that of a great portion of the head and face. It furnishes several muscles, particularly those concerned in mastication. It communicates not only with motive, but sensitive nerves, as the olfactory and optic; it forms the gustatory, and in some animals the auditory. It confers a peculiar sensitiveness on the skin, and affords a great resistance to the power of cold. Some of its branches keep up a consent between the skin and the membraneous coverings of the organs, as the conjunctive membrane of the eye, the Schneiderian of the nose, and others; and as the skin appreciates the extremes of heat and cold better than the membranes, it guards them by causing a sympathetic contraction of the muscles, which close the entrance to them. From its combination with so many different nerves, and particularly in the cod, it appears to perform more important functions than a sensitive nerve of the spine; for, whilst it furnishes parts with sensibility, it connects them in sympathy with others. It may have a participation of similar functions with the sympathetic, on account of its extensive connection with several nerves in many animals, so that the muscles of the lips or other organs may be either directly excited by irritants applied to the skin, or more indirectly through sympathy with the disturbed functions of the viscera. When belladonna is applied to the eye-brow, its influence passes from the branches of the first trunk of the fifth to the lenticular ganglion, and thus through a sensitive nerve the motive portion of the third is paralysed.

Although it generally divides into three trunks, and each emerges from the cranium at a separate opening, there is not on this account any peculiarity in their functions. Corresponding branches of each trunk vary in different animals, that they may be accommodated to the modifications of the form of the several parts of the head and face, and the changes of position during the action of the muscles, as in the issue of the superior maxillary nerve at several openings in the baboon and monkey, and of the inferior maxillary in the baboon and pig. The division into branches is for convenience; as the first trunk supplies the upper eye-lid, the second often part of the upper as well as the lower, the first the skin of the forehead, and the second and third that of the temple; and, in some animals, several of these parts are furnished with branches directly from the Gasserian ganglion.

Portions of the fifth undergo further changes in ganglia, so that the spheno-palatine in man becomes like part of the sympathetic; but these are noticed in the observations on the sympathetic nerve. The superior nasal nerve does not communicate with another ganglion after it has left the Gasserian, as the lateral nasal does with the Vidian in the calf and others, except indirectly with the lenticular in some instances. It is probable that it ministers more to the functions of the periosteum and integuments, and less to those of the Schneiderian membrane, than the lateral nasal. There is not anything very worthy of notice with respect to the branches given off by the fifth, for several, although very intricate from their passage through portions of bone, do not derive any peculiar advantage except that of safety and convenience; it does not therefore appear necessary to dwell on each particular branch.—The principal gustatory nerve is a branch of the fifth; it does not appear different from the rest of this nerve, although a ganglionic enlargement is sometimes found on it in man. Of all the nerves of the special senses, it alone proceeds from a mass of nerves destined for other parts, except the auditory in some fishes. Its perceptions are modified and appreciated according to the peculiarity of the nervous system, the structure of the tongue and other organs; it is thus able to select food the most agreeable to the nature or constitution of the whole body. Its perceptions of particular substances are pleasant to one animal, and very disagreeable to another, but this variation takes place even in man; it is therefore not always owing to the difference of construction found in each animal, but to some inappreciable peculiarity of the brain, the nerve itself, or those associated with it, which may have had their functions disturbed by offensive food or other irritating cause. The sense of taste is not produced unsolicited, like that of smelling or hearing, but for its perfection requires the surface of the tongue to be applied to the palate. In this mechanical development of its powers it approaches the nerves of feeling. The sense cannot be the entire product of the nerve, as branches from the same trunk supply the inside of the cheek on which vivid impressions are made, but these are not even similar to taste: if, therefore, the nerves be the same, the difference must arise partly from the structure of the tongue, and in some degree from the contact of this organ with the palate. Mammalia have a less exquisite sense than man, and birds, amphibia and fishes still less. There may be some satisfaction in transmitting the food through the mouth, but the gratification, in many instances, appears to reside more in smelling, and the soothing influence produced on the nerves of the crop or stomach. Nevertheless, as the size of the gustatory nerve varies as well as that of the par vagum, the sense of taste may be more acute and grateful in some, and the feelings of hunger and the sensations arising from the presence and the digestion of the food in others. The gustatory nerve in mammalia gives a faculty to the tongue not possessed by birds, and is moreover connected with the principal nerves exciting mastication.

In the movements of the lower jaw two most important purposes are to be answered, viz., mastication and speech. In the former considerable power is required, but in the latter a very gentle motion is necessary. All the muscles for this purpose are supplied by the third trunk, except the superior belly of the digastric and the genio-hyoideal. The same muscles and nerves perform both operations—one requiring so much power, the other so much nicety of motion. Thus the muscles moving the jaw and those of the bone and teeth are associated, otherwise a useless or injurious force might be employed; and the surface of the tongue, as the seat of taste, in mammalia at least, has its nerves associated with those exciting the movements of the jaw, as both must generally be in action together in mastication as well as in speech, and for the same operations it is required that the muscles of the lips should, with some modifications, be associated with those of the jaws.

The muscular structure of the face and lips answers two principal uses: the one is connected with the modulation of the voice and the development of the features, the other with the reception of food into the mouth, and mastication; the former function depends most upon the hard portion, the latter upon branches of the fifth. The upper belly of the digastric muscle in man is supplied by a branch of the hard portion, which communicates with the glosso-pharyngeal, and is thus associated with the pharynx, and these parts acting together assist in the modulation of the voice; the maxillary portion of the digastric muscle may act alone for the reception of food, and both portions together with the lips in speaking, singing, and other operations.

Some doubt exists as to the precise functions of every part of the fifth, several branches being distributed on muscles, which are at the same time furnished by other nerves. The muscles in general receive similar nerves, but some having particular functions, as each of the three slender ones arising from the styloid process, are supplied from different sources. This arrangement cannot be for mere convenience, as either of the nerves might have furnished branches to the whole. A muscle may perform more complex functions, and have two distinct nerves, as the digastric, or one may be supplied by two conjoined, as the cutaneous of the neck in man, the omo-hyoideal and others. A muscle in the face may also receive two different nerves, which may be either separate or conjoined. The superior belly of the digastric receives a branch from the hard portion of the seventh, the inferior from the mylo-hyoideal branch of the inferior dental. If the inferior dental just before entering the jaw can give off a branch for exciting muscular action, others distributed to the muscles of the lower lip may perform similar functions. Branches from the fifth and the hard portion may be separately traced to a levator muscle in the upper lip in the calf, but in the pig similar muscles used for rooting are supplied by the hard portion only: in the pig it is only near the snout that branches of the hard portion become connected with those of the superior maxillary nerve, when very little more remains than the small muscles combined with the skin of the snout and lips, in which the functions of both these parts are so much connected. Further, in the dog and fox, the mylo-hyoideal nerve, after supplying the inferior belly of the digastric muscle and the mylo-hyoideal, sends branches to join the hard portion in the face, and favours the conclusion that, in this as other instances, such combination allows the several parts to be employed together in complicated operations, or separately in more simple ones. In general, the union between the branches of the hard portion and those of the fifth, will not anatomically bear a comparison with that of the anterior and posterior bundle of each spinal nerve, although it be somewhat analogous to that in the spinal nerves of the cod.

As the auditory nerve is very similar in man and animals, any variation of function must depend upon the formation of the ear, their exquisiteness on the quality and perceptibility of the brain. Hearing in its usual simple state is a perception of impulses by a portion of membrane or skin, and very much akin to common feeling; it may be modified by the nerves spread on the tympanum. It is very probable that the membrane lining the tympanum may be impressed by particular sounds in a greater degree in some animals than in man, as the branches of the tympanine nerve of the glosso-pharyngeal are much larger, and particularly in the horse; it is, therefore, probable that the perceptibility thus produced does more than keep the tympanum in an excitable state. There is a considerable sympathy or association of action between the auditory nerve and the hard portion, as in the animation of the countenance in conversation, or during an interesting lecture, and the want of expression in a deaf person.

There is a degradation of the organ of hearing in those animals not having the membranous labyrinth surrounded by bone; it may be presumed, therefore, that the hardness of the frame-work in which it is incased is calculated for increasing its power of conveying sounds. It is most probable that very little difference exists between the capability of the labyrinth of mammalia and man. In birds, whose semicircular canals are so varied in form from those of mammalia, and particularly the cochlea, tunes and languages can be learnt and expressed, and there does not appear to be any deficiency of ordinary auditory functions: their power may be, in some respects, different, but the changes of form of the labyrinth and tympanum may be required on account of the structure of the head, and in some degree on account of the glottis. In amphibia and fishes, the semicircular canals and sacks are modified to the change of external communication, to their living in water, or nearly in contact with the ground, but there is a difficulty in ascertaining what species of sounds they can appreciate. The nerves, with some variation in their texture, are in a great degree similar in the four superior classes: the principal difference of hearing appears, therefore, to depend considerably on the capacity of the organ as well as the brain. The organ of hearing is a more independent mechanical instrument than that of seeing, as it is always ready for receiving impressions, and the contractions of its internal muscles are in a great degree involuntary, whilst the functions of the eye are almost entirely completed through the will in the direction of its muscles.

The functions of the hard portion of the seventh are very complicated. Its branches vary in their course, and are sometimes connected with those of the fifth, whilst in others they are only in apposition, and pass separately to the same muscle. It can, through its own inherent powers, actuate muscles, as all its branches are not combined with sentient nerves. For particular functions some branches of the fifth, or of the spinal nerves, are joined to it, and these, by communications with other nerves, may be further and variously modified in different animals. Some branches impart a contractile power to the cellular membrane and skin, and effect a proper consent between these and the structures beneath, whose functions are so intimately connected with each other. The cutaneous muscle of the neck receives also branches which have been joined by others from the cervical nerves. It is probable that this muscle contracts in singing and other operations, and by its particular situation admits of a more free action of the muscles and other parts of the throat, by removing in a considerable degree the pressure of the atmosphere.

The course of the chord of the tympanum over the head of the hammer and across the tympanum, as well as its conjunction with the gustatory nerve and the hard portion, is very remarkable. It might have passed from one of these nerves to the other without crossing the membrane of the tympanum; it must therefore have been thus placed to answer a specific purpose for receiving such an impulse, both from the membrane of the tympanum and the hammer, as may be conveyed to the gustatory nerve and the hard portion; it prevents a too forcible distension of the membrane of the tympanum, as it can appreciate any impulse from the air admitted by the external ear or the Eustachian tube. When very loud sounds are expected, the tympanum is kept nearly empty, and its membrane relaxed by expiration; and when faint ones are to be attended to, it is filled by a deep inspiration, and its membrane becomes stretched. These different states are thus nicely adjusted by the chord of the tympanum and the tympanine nerve of the glosso-pharyngeal. The chord of the tympanum communicates with the gustatory nerve, that there may be a due consent between the tongue and the tympanum for modifying sounds, and making it unnecessary for a person to listen to his own voice, as attention to speaking and hearing at the same moment interferes with both operations; it is very probable that this provision enables the deaf to speak so well. It may be supposed that it should rather have been connected with the ninth, through which the actions of the tongue are directed; but it was necessary to have a correspondence between the surface of the tongue and that of the tympanum, and as a nice adaptation of the tongue to the mouth is well produced through the sensitive nerve, and as there is a communication between this and the motive ninth, the present arrangement has been preferred. As the auditory nerve communicates with the hard portion, and this through the chord of the tympanum with the gustatory nerve, the whole may be excited at the same instant, and produce that corresponding state of the features, the hearing and articulation, observed in the act of speaking or singing. As the tongue appears to have very little power in the formation of sounds in many animals in which the chord of the tympanum exists, it may be presumed that this nerve answers other purposes than those ascribed to it. The sounds of animals are indeed principally guttural, and modified by the action of the mouth ; but it might with as much cause be objected that the nerves of the lips have very little influence in the production of speech, because precisely the same exist in animals ; and this reasoning may be applied to a great many other nerves : the difference of the extent of functions must therefore be sought for partly in the form of the organs, but principally in the brain.

The chord of the tympanum gives sensibility to one surface of the tympanum, whilst the tympanine nerve of the glosso-pharyngeal gives it to the other, that there may be a corresponding state between each surface and the membrane covering the tongue and throat ; so that whilst one associates the ear with the anterior part of the tongue as the organ of speech, the other connects it with the posterior part and the pharynx, on account of the voice, and all these together promote the functions of the tympanum. For further information on this subject see the author's *Treatise on Diseases and Injuries of the Nerves*, page 278.

Distributions of nerves may take place for particular functions, as when the muscles producing the features have separately or conjointly more varied actions, and not always on account of the shape of the parts, as in the comparison of the nerves of the face of a baboon with those of a dog. In the baboon, the branches of the hard portion pass over the masseter muscle nearly as in man, and not in a few large ones, as in the dog, horse, and others. In the baboon, the branches of the second trunk of the fifth pass through several foramina, and allow of more partial and particular muscular contractions than would have taken place had the nerves been more accumulated.

The distribution of the branches of the hard portion varies for a similar purpose in some degree in every kind and almost every species of animal, the simplicity or complexity of its branches principally depending upon those muscles connected with the anterior part of the face, the forehead and eyelids, which constitute the features and produce expression. As the masseter muscle is not supplied by this nerve, and as the large branches do not ramify much before they have passed over it, when it is very broad, the distribution appears very simple; consequently when it is narrow, the whole face is more covered. The functions of this nerve at its origin are similar in all animals, but those of its branches vary according to the complexity of the muscles supplied by them. Some of its branches are given off to suit the direction of the different muscles, and divide sooner or later, and communicate again for consentaneous actions, and join particular branches only of the various divisions of the fifth, so as to connect parts together according to their required functions. Its inferior branch often passes a little below the angle of the jaw, that it may not be exposed to injury from blows on this prominence; but in the pig, its defence, by keeping so much behind the jaw before it mounts up to the face, is very remarkable.

Different individuals vary from each other not only in appearance, but in their mental and corporeal powers. The endowments of the mind, although very much connected with the formation of the brain, are in a great measure matured by education. The corporeal powers depend not only on a stronger and more compact original structure of the various organs, but also on a greater development of the nerves, which may be further increased either by the exercise of particular parts in mechanical operations on extraneous matters, or entirely through the influence of the mind.

It would be curious, and in a sanatory point of view instructive, to determine how much the education, exercise, and diet of an individual affect his future progeny, in the general development of the nervous system, and whether mental cultivation may not produce an increase of particular branches of the nerves of the face, and a singularity of features, transmissible to the offspring. Peculiarities may arise from original formations, or be acquired from changes wrought by the mind on the brain, or by the constant action of muscles producing particular features, and a consequently greater development of the branches of nerves supplying them. In all subjects there is the same order with respect to the largest branches of the hard portion of the seventh, but not in the smaller ones, and although there is not much variation in the muscles, integuments, and form of the bones in some individuals, there is a very striking dissimilarity in the features. If the change in the actions and associations of the muscles can be effected through variations of the nerves, as well as the brain, then this diversity of the branches of the hard portion may be the intended order of nature, and necessary for the expression of character. As branches of the fifth perform uniform functions, and do not seem to be much connected with the mind, they do not vary so much as those of the hard portion. It is, however, probable that these, with the muscles and bones, may be enlarged through particular uses, as in the mastication of dry grain, or other hard substances.

The glosso-pharyngeal nerve has both sensitive and motive properties, and from the effect of an irritating body applied to the different parts of the tongue and throat, and from its origin and distribution, its perceptive faculties are such as appear to be a modification between those of the fifth and the par vagum. The tympanine nerve is ramified in the same beautiful manner in mammalia as in man, but is much larger in proportion to the size of the human labyrinth, to which there is so great a resemblance; it must therefore be concluded that it exists principally for the uses of the tympanum. For further information on this subject, see the author's *Treatise on Diseases and Injuries of the Nerves,* page 270.

From the small size of the portion of the glosso-pharyngeal nerve given to the posterior part of the tongue, it is probable that its influence in exciting any sense of taste is not extensive, and it is difficult to conceive that experiments can be made on this nerve, without influencing the perceptions of the whole tongue.

Particular parts of the mouth and tongue are supplied by different nerves; the cheeks, and the anterior portion of the surface of the tongue, in mammalia, are furnished by the fifth; the posterior, as far as the epiglottis, by the glosso-pharyngeal; the pharynx by the glosso-pharyngeal, par vagum, accessory, and sympathetic; whilst the œsophagus, and larynx, and trachea, are furnished by the par vagum. Besides the usual nerves, branches of the sympathetic pass on the arteries to the tongue, and form another source of action, and keep up sympathies by their communications with the nerves distributed on many of the viscera. The varied functions of the several parts of the tongue in health, and their different states in disease, are produced by distinct nerves, each exercising its appropriate powers, locally and sympathetically, according to the particular connections of the several nerves with others.

It is curious that each of the slender muscles arising from the styloid process, both in man and animals, should have a different nerve. In man, the stylo-pharyngeal receives a branch from the glosso-pharyngeal, and is principally subservient to the common uses of the pharynx, but may be associated with the complicated operations directed by the pharyngeal plexus. The other two muscles are adapted, by their slender form, for uses requiring light and varied movements, as in the modulations of the voice, and sounds, and their different notes. The pharyngeal plexus associates several parts concerned in respiration and deglutition, and particularly in modulations of the voice and speech, whilst its ramifications on the arteries regulate the supply of blood.

The par vagum is one of the most complicated nerves; it produces sensation in an eminent degree, also both voluntary and involuntary muscular action: the one being manifested in the glottis in singing, and in the stomachs of ruminating animals; the other through contact of foreign bodies and noxious vapors with the membrane of the larynx. It appears to be the only cerebral nerve whose functions continue active during sleep. Its perceptive powers are very peculiar, and well calculated for promoting the nice adaptation of the moveable parts of the glottis in the exercise of the voice in singing, &c., and for guarding against the admission of impure air and extraneous matters, which would be perpetually endangering the lungs, or even life. It is connected with the pharyngeal plexus for promoting consentaneous actions between the larynx and pharynx in complicated operations relating to the voice, swallowing, &c.; it is joined with the cardiac nerves, that the heart may be associated with the lungs and with the brain, as the functions of these organs depend so much upon the proper action of the heart. Neither the connections of the par vagum with the ninth, nor of these with the sympathetic, are generally the same as in man; slight variations of function may be thus produced, but it is difficult to appreciate them.

The trunk of the par vagum and the beginning of the recurrent nerve encircle the subclavian artery on the right side and the aorta on the left; this disposition may have been intended for producing a sympathy between the sanguiferous system and the glottis, for when the action of these arteries is increased by exercise, the recurrent nerves become excited in a proportionate degree, and consequently the muscles opening the glottis, and thus a more free access of the air to the lungs is accomplished. Communicating branches between the recurrent and cardiac nerves associate the functions of the trachea and larynx with the heart.

In mammalia, the recurrent nerves have the same disposition as in man, and are subject to similar variations. In a rabbit, the right subclavian artery arose from the aorta, and crossed the spine behind the œsophagus to its destination; it was embraced by branches of the sympathetic passing to the first thoracic ganglion in the usual way. Although the right recurrent nerve was not situated behind the artery, it arose at the ordinary place from the trunk of the par vagum, formed its usual connections with the sympathetic, and ascended exactly to its accustomed destination. Why, in this instance, was the subclavian artery embraced by the sympathetic and not by the recurrent nerve? The answer is plain, that the nerves are formed independently of any mechanical influence of the arteries during the evolution of the fœtus, and that there was an error in the origin of the artery, but not in that of the nerves. It is probable that the recurrent nerves supply the moveable parts through which they pass more conveniently and safely, in some instances, than branches given off from the trunk of the par vagum could have done; but in others, as the snake, much of the trachea is furnished by filaments from the trunk of the par vagum, the recurrents being very small. In many animals the recurrent nerves, as well as several branches of the sympathetic, have their very remarkable disposition with respect to the large arteries for a peculiar purpose. It is improbable that one portion of the very delicate structures, during the early evolution of the fœtus, prevails over another, according to mechanical laws, but that the formative process, with respect to the whole, is directed by the vital power, the working of which has not been detected.

The branches destined for the lungs terminate almost entirely on the divisions of the trachea and air-cells, for maintaining these in such a state of action as favours the ingress and egress of the air, and gives them at the same time sufficient perceptibility.

There is a great communication and interchange of position in each trunk on the œsophagus; it is probable that this occasions a unity of action between both, and after this the continuation of two chords through the diaphragm is for the greater convenience of supplying both surfaces of the stomach, so that there may not be any undue stretching when this organ is full, and also for forming a convenient connection with the splanchnic plexuses of the sympathetic. The difference in the arrangement of the two chords of the par vagum in other classes appears to be principally for convenience; for whilst in the turtle they are separate, in the snake, and birds generally, the largest portion of both passes for some distance united into a single chord.

It is consonant with the simplicity of the plans of nature that the larynx, trachea and lungs, should be supplied by this nerve, and that the heart should be associated with them, but why there should be an intimate connection with the stomach, the intestines, the liver, and other viscera, does not appear at first so plain. The food, being digested in the stomach, undergoes a modified change in the intestines, but the chyle is subjected to a further assimilation in the lungs for its conversion into blood, so that the animalization or revivication of the food begun in the digestive organs is completed in the lungs, but whether through air admitted into the cells supplied by the nerves, or immediately through the nerves themselves, is difficult to determine.

Both the peculiar, sensitive, and motive properties of the par vagum, are necessary for the functions of the villous and muscular coats of the stomach. The stomach has also contributions from the sympathetic; but these, although communicating with the branches of the par vagum, are conducted along the arteries as in the other viscera, and may promote the secretion of gastric juice, as well as that of the intestines, and determine a requisite supply of blood to the spleen. But if the par vagum promote digestion in the stomach, and the assimilation of chyle into blood in the lungs, why are its branches given to the liver? The parenchymatous structure of the liver may derive some contractile power from it, but the principal supply of nerves is from the right semilunar ganglion of the sympathetic. The branches of the sympathetic alone suffice for the secretion of bile; but this function, through the par vagum, is associated with that of the other organs, to which there is a great flow of blood during digestion: the portal vein, therefore, in sharing some part of the excitement, disperses through the lobules of the liver the increased quantity of blood returned to it, and produces the copious secretion of bile, which assists in the assimilation of the food, whilst the lungs are at the same time most opportunely relieved of an inordinate influx from the veins during the reception of the chyle and the completion of its conversion into blood.

The par vagum connects the lungs and digestive organs, not only as completing the same purpose, but as preventing any irregularity between the supply of chyle and its conversion into blood in the lungs. This combination of function in delicate persons requires that all the organs should be undisturbed when chylefaction is going on; for lecturing, or any violent exercise of the body, causes the air to be irregularly admitted, the circulation hurried, and the deliberate flow of chyle into the blood prevented.

It may be a question whether the appetite for food depends on the state of the par vagum or the nervous system generally. It is a consciousness of deficient power when the body is in health, a craving for or want of its renovation. The natural support or stimulus of the powers of the nervous system is derived from blood replenished by chyle, which has undergone changes in the lungs through the influence of oxygen. It seems, however, that the supply of chyle is not always necessary for this purpose, but blood changed in the lungs even through the influence of any stimulus; as spirits, narcotics, and other things can, for a time, renovate the nervous system, and allow wearied and almost powerless muscles to renew their exertions; but this state of things is contrary to the continuance of health, for the nervous system thus becomes gradually debilitated and the physical powers of the body diminished, as its waning energies have been stifled by poison instead of their having been fostered by proper nutriment.

When the numerous communications between the par vagum and sympathetic are considered, it must be concluded, that particular branches are united for specific functions, and that a mere connection, as of the trunks in the neck, is not sufficient for such purposes. Its conjunction with the semilunar ganglia connects the viscera of the abdomen with the animal parts of the brain, and through these with the intellectual; and it is probable that, the more extensive the intellectual portions of the brain are, when compared with the size of the animal, the more easily the stomach is disordered by the quality or quantity of the food, and the more careful, therefore, the animal is in selecting this; and by the same means the passions more or less affect the other viscera. In man, the greater the faculties of the brain, and the more they are exalted by education, the greater is the necessity of a restraining moral influence for the preservation of health.

The par vagum may be of a larger size in some animals than in others, for very different purposes; it may be large in proportion to the capacity of the stomach; it may, in carnivorous animals, cause the ravenous desire for food and promote its digestion, as there is in these animals a greater proportion of cerebral nerves to the extent of the digestive organs usually supplied by the par vagum; in the pig it may be large on account of the size of the stomach, as well as the greedy disposition; it may be large in ruminating animals on account of the numerous stomachs supplied, and yet the branches distributed in the true stomach may not be larger in proportion to those of the ass. It is difficult to draw any just conclusions respecting the variations in the size of the par vagum, without a knowledge of the structure and capacity of the lungs and stomach, and the demands of the cœliac plexus; the size of the animal and its general condition require to be also taken into account, as in the human subject alone it is found to vary according to the nature of the disease.

The functions of the par vagum appear to be nearly the same in the four superior classes of animals, notwithstanding the variations of shape and structure of the organs supplied by it; it may, however, be modified either by the peculiarity of the brain, its mode of origin, or its conjunction with the sympathetic nerve, the varying structure of the organs receiving it and the supply of blood. It furnishes branches to the delicate lungs of mammalia, the more open or fleshy ones of birds, the cellular or vesicular of amphibia, and the rudiments of these organs in the air-bags of some fishes, as well as the gills. The stomachs supplied by it vary in an almost equal degree, as in the simple one of many of the mammalia, and the different degrees of complexity in others; the thin fleshy stomachs of carnivorous birds, and the thick and powerful gizzard of the granivorous and graminivorous; and the varying stomachs of amphibia and fishes.

In some fishes the fifth sends off a dorsal branch to communicate with all the nerves of the fins, and supply some portion of the skin, as in the cod, but in the skate this does not exist; in both, however, there is a dorsal branch of the par vagum. As fishes have the power of discerning the difference, and choosing for particular purposes an agreeable water, it is most probable that this branch of the par vagum is connected with the functions of the gills, the air-bag and stomach, and for determining whether the water be of a proper depth and purity for coming in contact with the gills, or may contain food agreeable to the nature of each species. In the skate, it does not pass underneath the skin until it reaches the tail; it is not, therefore, for the secretion of mucus or the functions of the skin, but for allowing the creature to ascertain by its tail the state of the bottom which it approaches.

The ninth in some of its functions resembles the par vagum, as it is not a rare occurrence for its usual descending branch to be given off by this nerve. It is associated with the gustatory nerve, as the nice adaptation of the tongue to the palate is required for taste and speech. It communicates with the par vagum, as some of the functions of the glottis and tongue are combined, and it is conjoined with the cervical nerves, that all the muscles supplied by these may be able to act in unison with parts concerned in the production of sounds, speech, and other respiratory movements. Its distribution and functions in animals are similar to those in man, and it appears to be concerned in promoting the action of the muscles of the tongue and others connected with the hyoid bone and thyroid cartilage; but the descending branch in many animals is very small, and united with different cervical nerves for favouring the peculiarities of the required motions. Its power of moving the tongue for the production of language does not appear to arise from any connection with other nerves, but from the brain; words may be impressed on the brain through the ear in any animal, but it requires particular conditions for their utterance, as in the parrot and other birds; and it is not a little remarkable, that several birds utter words, whilst mammalia, in which there is so much greater an affinity of parts, have not this power, even in a single instance.

It is probable that the ninth supplies such of the muscles as have simple actions, but that some of the parts of the tongue, and particularly the pectinated muscular surface, require to have filaments of the sentient or gustatory nerve, for promoting the more complicated functions. In the same manner, some of the muscles of the throat are supplied by the ninth only, whilst others also receive branches from spinal nerves.

In many animals, it forms a firm membraneous attachment to the par vagum and accessory; a similar attachment in other nerves is not unusual: in man, there is a distinct nervous combination in the midst of this, but in several animals it has appeared to be almost wholly a strong or dense membrane. It is difficult to determine whether this union answers other purposes than that of forming in a considerable degree a mutual support.

There is a singularity in the origin and course of the accessory nerve, and particularly in its connection with the posterior surface of the spinal chord, and the posterior bundles of the spinal nerves, before these have left the sheath formed by the dura mater. Its receiving filaments near the origin of the par vagum, is not less remarkable. If contiguity of origin confers similar properties, it may be supposed to be assimilated with the par vagum and the glosso-pharyngeal. As it arises from the part of the chord, and the nerves to which sensitive properties are attributed, and as it has motive ones, much consideration is necessary before distinctive qualities are conceded to mere locality of connection of nervous fibrils with the brain and spinal chord. Its most probable use is, in being subservient to the pharynx in steadying the head in eating and drinking, and it is therefore connected with the nerves of the pharynx. It may, in a similar manner, allow of a more effective action of the muscles of the hyoid bone and thyroid cartilage, which are attached to the sternum, and thus assist the larynx in operations of the voice, or in playing on wind instruments. It does not appear to be originally formed for respiration; it may, however, be stimulated, as all the other nerves are, in extreme necessity, and then assist in promoting this process.

The external appearance and internal structure of the spinal marrow in mammalia are nearly the same as in man. On its division a considerable space intervenes, and thus shows its elasticity. After a sufficient immersion in spirits, it is found to be composed of coarse longitudinal fibres interrupted by others placed transversely. Its intimate structure is a fine cellular tissue containing the medullary and cineritious matter. Its enlargements are more or less extensive according to the number and size of the nerves furnished by it in a given space, and the motion to which the different parts must be subjected. It need not correspond with the extent of the spinal canal, but may have a greater or less portion of its length supplied by nerves, when such a substitution is more convenient. In the hedgehog, it is short and thick, and terminates very high up; its point reaching to about the sixth dorsal vertebra. In man, its extreme point reaches to the second lumbar vertebra; but the thick portion, forming the principal part of the centre of the cauda equina, is placed much higher up. In the baboon and monkey, it descends a little lower, the thick portion extending to the bottom of the second lumbar vertebra, and its point reaching to the inferior part of the fourth; in a very small monkey, its point reached to the bottom of the fifth; its thick portion extends to about the bottom of the sixth lumbar vertebra in the calf, goat, dog, jaguar, pig, and other animals, and its point into the canal of the sacrum. When therefore it is shorter, the nerves of the cauda equina occupy a greater length of the spinal canal, so that they are longest in the hedgehog, next in man and some animals, whilst in others they are very short, with the exception of several slender ones continued through the canal to some distance into the tail. The nerves arising from it consist of an anterior and posterior row of bundles on each side. In the recent spinal marrow of an ass, filaments from both the anterior and posterior surface were traced to the grey matter, and the confines of this appeared to be incorporated with the medullary. The quantity of the medullary matter preponderated very much over the grey. The fibrils of the posterior bundles are by far the coarsest, and have ganglia attached to them on leaving the spinal sheath; these are not always placed as in man, but in the baboon, the dorsal, lumbar, and sacral, are contained within the spinal canal; and in some animals, as the ass, calf, and goat, are not so compact as in man, the baboon, jaguar, dog, fox, pig, and others, but of a coarser texture, and have less of the red matter intervening between the nervous fibrils; at the anterior point each ganglion is joined by the anterior bundle to form a nerve, in which the fibrils of both become intermixed. In the ass, the different bundles of fibrils composing a cervical nerve, having passed through separate openings in the sheath of the dura mater, form little ganglia, which communicate together just at the beginning of the nerve; it is nearly the same in the calf and goat. The disposition of a ganglion in man has been before noticed, and it is very similar in the baboon, monkey, dog, and others, and the principal difference in numerous animals consists of a greater or less separation of the fibrils in a varying quantity of red matter.

In the jaguar the nine, and in the sow the seven first bundles of dorsal nerves, point downwards; the remaining dorsal and the two first lumbar point upwards, in passing to the ganglia, which are placed at the notches leading from the spinal canal; so that by taking a direction each way towards the most bending portion of the spinal marrow, they are prevented from being stretched when the animal bends the back much, and particularly in springing forwards. The third lumbar ganglion begins to incline downwards, and the rest of the lumbar and sacral then take almost a perpendicular direction.

Whatever may be the dimensions of the spinal marrow, its structure and functions are nearly uniform; it may therefore be presumed that any change in its shape and size at different parts is for the convenience of sending off its nerves, and adapting it to the required motion of the several portions of the spine. It is therefore to be regarded in two points of view; firstly, as to its appropriate functions; secondly, as to its mechanical relations to other parts.

It is continued in a canal formed by the rings placed behind the bodies of the vertebræ; and as these have different motive capabilities in each region of the spinal column, the utmost nicety is required in adapting its delicate texture to their convenience. The spine has not only to sustain the head and form the centre of the trunk during a state of quietude, but also during that of exertion. It must be accommodated to the required strength of the animal, to the position and free action of the limbs, the swiftness of motion, and to the support of the viscera, which are placed on its anterior part. In man, the degree of flexion of all the cervical vertebræ together is very moderate, very little in the dorsal, but in the lumbar it is considerable, more particularly in the lower. In the baboon, the relation of the parts approaches that in man. In many animals, which always move on all-fours, a great change takes place; there is a less or greater capability of bending the neck, but much greater at the dorsal portion of the spine, and this is seen in a remarkable degree in the hedgehog, which draws the lower part of the body towards the upper, when it becomes folded into a ball within the skin; in others, the flexion of the dorsal vertebræ is for a very different purpose; in the sow, it forms an arch, by which the weight of the young, the extensive mammæ, and capacious viscera, are better and more safely sustained; in others, as the jaguar, it allows the spine to be shortened in swift paces, and therefore the hind legs to be brought more forward at each spring than they otherwise could have been; in such instances, there is very little motion of the lumbar vertebræ, which are required to afford a fixed point for the attachment of the muscles concerned in springing forwards. As the spine of many animals varies so much in its capabilities for motion, the same form of spinal marrow would not be convenient without some risk of its exposure to injury.

At first sight it appears easy to accommodate the spinal marrow to an immoveable canal, but it cannot be done without additional contrivances; for in many birds there is no motion allowed in the dorsal portion, which, therefore, is closely surrounded by a thin plate of vitreous bone; so that in rapid flight, if any shocks are communicated to it, they are expended or diminished in the fluid contained in the lumbar ventricle; and in the turtle, the same intention is answered by not having the back of the skull closely impacted on the whole spine, otherwise the animal would have been always in danger of destruction by coming in forcible contact with hard substances.

The cervical portion of the spinal marrow is continued from the oblong medulla, for giving origin to the nerves of the muscles and skin of the neck and the anterior extremities, and is well accommodated within the canal of the cervical vertebræ, where only a moderate degree of flexion is permitted. In animals with longer necks, it is somewhat thinner in proportion than in those with shorter ones, but varies according to the size and number of nerves required to issue from it; the thicker portion giving off the axillary plexus appears therefore to be placed lower down in those having long necks. When there is to be extensive motion, as in the neck of some birds, it is thin until it reaches near to the fixed dorsal vertebræ. In the middle of the crane's neck some of the vertebræ bend at an acute angle, not allowable without space in the canal and thinness of the spinal marrow. In the dorsal vertebræ of man, its thinness would have admitted a greater degree of flexion, but the spine is required to allow very little on account of the necessity of maintaining an erect position of the body, and supporting the viscera, which are adapted in a considerable degree to its state; in many genera, however, flexion of the spinal marrow in the dorsal vertebræ is necessarily permitted. In many animals which spring forward by bending the back, the spinal marrow is thin nearly throughout the canal of the dorsal, and part of the lumbar vertebræ, and may be particularly observed in the jaguar. The lower portion of the spinal marrow, forming the cauda equina, varies very much as to its situation in the spinal canal in different animals, and in the same at particular periods of life. When therefore the spinal marrow is shorter, the nerves of the cauda equina reach through a greater length of the spinal canal, and are longest in the hedgehog, next in man and some animals, whilst in others they are very short, with the exception of several slender ones continued through the canal to some distance into the tail. As in many instances much motion in the lower part of the spine is not required, the extremity of the spinal marrow giving origin to the nerves of the cauda equina is extended into it and lodged in perfect security, and this thick portion would have been inconveniently placed higher up, as flexion of the body, particularly at the dorsal vertebræ, for springing forward in swift paces could not have been so free, for the canal must have been more capacious at that part, consequently the bones heavier, and the muscles larger. But in man, who bends forward the trunk principally at the loins, in the baboon and some others, very little more than the nerves of the cauda equina reach through a great extent of the lumbar vertebræ, and therefore a degree of flexion at this part is permitted, that would have injured the spinal marrow, had it been continued so low down as it is in a great many different animals. From the examination of the spinal marrow of different animals, it appears that its dimensions must be proportioned to the quantity of nerves required to proceed from it, and its largest portion must be placed where it cannot be subjected to undue flexion; and if it be contained in parts having extensive motions, as in the necks of some birds, and the tails of various animals, it must have undergone a sufficient diminution in its circumference. From the consideration of these facts, it is clear that many of the shapes of the nervous centres are subservient to mechanical convenience, as the form or extent in length or breadth of the spinal marrow does not seem to be necessary for perforating the functions of particular muscles, or varieties of the skin, but to differ according to the size and extent of both.

Whatever may be the length of the spinal marrow, and however numerous its nerves, it may either preserve the same dimensions throughout to the tail, as in serpents, or gradually become narrower, as in many fishes, after the origin of the nerves which supply the thickest part of the body; or in animals of different classes it may be narrower or wider in several places. This variation being according to the required issue of nerves, it is probable that the portion, from which each nerve arises, sustains all the vital powers, and forms a centre or source of influence to and from which its excited faculties are propagated, and that even motion unconnected with the will, and sensation not appreciable by the mind, may depend on this origin, and produce together several phenomena both in healthy and diseased states of the body.

Each portion of the spinal marrow has its particular communication with the brain, and the slender medium existing between it and the spinal chord of the lobster, and the nervous ring of the crab, show how small a conjunction is necessary for imparting or transmitting the commands of the will to the muscles, and sensations to the skin. Its structure, and the precise order of its nerves and ganglia, declare a uniformity of purpose throughout, but do not account for the diversity of motion performed by the muscles in different animals. The power of regulating these actions must be attributed to the brain; it is perfect at various periods, and even in some animals at birth, through the maturity of the brain or cerebellum, as well as that of the limbs.

The spinal marrow in man and animals is proportionate with the trunk, and, except some difference in its component parts, in fishes and amphibia does not undergo much variation, particularly in mammalia and birds, nor is it subjected to many diseases, except such as are consequent on those of the vertebræ. In the upright condition of man and some animals, it is placed vertically, but in the recumbent, horizontally, nearly as it is generally in numerous animals. It is not, therefore, the recumbent position producing a change in this organ, which renders a person unable to sit up after a long confinement, but the change of circulation in the brain, the weakening of the ligaments and muscles of the spine, and the softening of the bones. The head of an animal, although depending, is not submitted to such changes with respect to the blood-vessels as that of man, particularly after an uninterrupted continuance in a recumbent position for a long period.

Although the spinal marrow is of so delicate a structure, and on exposure to the air becomes so soon decomposed, it may undergo very considerable pressure without its being subjected to such changes as would take place in other organs during life; for it is not unusual to see it indented, or the medullary matter even pressed upwards or downwards, by diseased or fractured bone; its functions, however, as the connecting medium between the nerves and the brain, are thus diminished or destroyed.

There is a general resemblance of the spinal nerves in mammalia to those in man. They vary in number with the vertebræ, and in size and distribution with the extent and shape of the parts receiving them. The number of cervical nerves is the same as in man; the sub-occipital generally emerges from a foramen in the atlas, but in the rest there is not anything remarkable, except the greater or less extent of surface of the spinal marrow from which each nerve arises. The number of dorsal nerves is seldom fewer but often greater than in man, and varies with that of the dorsal vertebræ and ribs; the number of the lumbar, and sacral and caudal, varies with the corresponding portions of the spine, but the distribution is very similar to that in man, allowance being made for the size of the parts to be supplied; the anterior trunks of the lower sacral and caudal nerves form an anterior nerve on each side, whilst the posterior form the posterior, which corresponds with the continuation of the plexus at the back of the sacrum in man.

Each nerve, after the union of the anterior bundle with the posterior beyond the ganglion, is divided into an anterior and posterior trunk; the anterior is generally by far the largest, and furnishes many branches to parts situated near it, and enters into the principal plexuses, as the axillary, sciatic, and others; the posterior is generally small, but varies with the quantity of muscles and skin supplied by it. The nerves in all the mammalia are distributed to corresponding parts, but are larger or smaller according to the magnitude of the skeleton, and join sooner or later at different angles, or take a retrograde course on account of the situation or action of a muscle, or are protected either by a foramen, a notch, or ligament, when their passage over a bone would have diverted them too much, or have exposed them to injury: they are made broad and flat when they will lie more conveniently on a bone or fascia, or between large and powerful muscles, the contractions of which might compress them if they were narrower and thicker. From even a limited survey of the distributions of the same nerves in different animals, it will appear that many variations take place for the mechanical adaptation to neighbouring parts, but that others occur for forming either an exaltation of some faculties or for combining several organs for a particular purpose.

The number of cervical vertebræ being always the same in mammalia, when the neck is long the nerves are placed at a proportionately greater distance from each other; if therefore the four inferior had always entered the axillary plexus, as in man, some of them must have been conducted to it in a manner quite incompatible with the free motion of the spine and the upper extremity; therefore it is generally composed of fewer and larger nerves, and so long as there is the same regularity in the origin of the fibrils from the spinal marrow, their collection into few or many nerves, or into larger or smaller, is of no importance, for in the hedgehog, the whole body receives its nerves from a spinal marrow, occupying only a small part of the spinal canal. In the fox, the two chords forming the median nerve do not unite at the upper part of the humerus, as in man, but at the lower, at a very acute angle; there is, however, some variation in different subjects, and even the two limbs of the same. This formation of the median nerve is presumed to be a matter of convenience, for favouring the easy motion of the limb; the internal brachial muscle is supplied by a branch of one of these chords, which takes a recurrent course to it from the elbow, otherwise it must have crossed the humerus, and been exposed to injury from pressure, or from stretching, by the action of the muscle receiving it.

In the baboon, the nerves of the palm of the hand are small in proportion to those in man, and do not terminate in such thick brushes of filaments at the tips of the fingers, and therefore are not near so well calculated for perfecting the sense of touch. The nerves derived from the radial branch of the spiral, and the dorsal of the ulnar, supplying the back of the hand and fingers, are much larger in proportion to the same in man. The nerves of the hand in the baboon are a little larger than those of the foot; it may therefore be concluded, that although the hand be not a sense of touch equal to that in man, it is endowed with a somewhat higher degree of perceptibility than the foot. This faculty is variously modified in different animals by the shape of the foot, as well as by the structure of the skin, and is frequently so much altered as to possess merely common feeling. It is also varied by the different texture of the nerves, and the peculiarity of the brain from which they originate, as well as the medium through which the impression is conveyed, as air, water, heat, cold, &c. In many animals, as the anterior extremities exist principally for supporting the body, the large branches of the fifth spread on the snout answer the purpose of the sense of touch, but are smaller when the nerves of the fingers, as in the baboon, approach the proportion of those in man.

In the part of the ass corresponding with the hand and foot, there are not any muscles, but only tendons, ligaments, and integuments; all the same nerves are nevertheless continued into the foot, as in other animals, but terminate in a single toe, instead of the four or five of other creatures, the difference consisting in their not being so much subdivided. This disposition obviates the compression to which fewer and larger nerves would be exposed, and in accidents secures the integrity of some; it also produces a sufficient consent between the different textures of the foot, and the various muscles belonging to the limb, and thus the whole contribute to the free and forcible direction of the foot, and particularly its firm position on the ground. Where there are several toes, still this association with all the muscles of the limb, with some modification, is required; and when there are several fingers, as in the human hand, it is necessary for perfecting the sense of touch, and all nice operations connected with this faculty.

From the situation of several slender nerves, as the saphenus and its communicating branch of the obturator, it is very probable that whilst they accompany, and are in some measure subservient to the veins, they supply the adjacent parts, and act as monitors for allowing an extent of motion capable of being made without pain in the different positions of the limb, and thus prevent an overstraining of structures which have a less degree of perceptibility, and when injured, an inferior power of restoration; they also more certainly preserve some communication between the extreme parts and the nervous centres, in case of injury to the other nerves by accidents and diseases.

In some animals, as in man, a ganglion is attached to the termination of the spiral nerve at the back of the wrist for supplying the carpal joints, and an enlargement or expansion of the outer branch of the anterior tibial below the annular ligament for the tarsal. In the baboon, there is a ganglion for the carpal, but only a flat brush of filaments, without any appearance of the ganglion for the tarsal. In the jaguar, there is a very slight enlargement of the nerve for the carpal and tarsal, but not a ganglion. In the fox, there are only filaments for both the carpal and tarsal joints proceeding from the nerve, and not from a ganglion. In the ass, the one for the carpal joint is broader than the nerve, but has not a ganglionic appearance, nor has the branch of the anterior tibial for the tarsal. As the joints are generally supplied by ordinary nerves, it may be a question whether the ganglion answers any other purpose than that of forming a close union with the ligaments, and thus accommodating itself better for sending off its branches more safely, when these joints are subjected to the most complicated movements. The nerves given to healthy bones are very fine filaments, but several weeks after a fracture are found much enlarged.

Some of the sub-cutaneous nerves of different animals are covered with and pass through the fat and other parts, as in the fingers, the nose and lips, so as to present larger points in brushes of filaments to the surface of the skin, but this mode of distribution in the feet of animals is much less developed than in man; others are placed in adhesion with the skin, and their close contact allows this part a greater capability of being folded, but is not so favourable to acute perception. In the monkey, the skin is thin and free from fat; the cutaneous nerves can be seen terminating most distinctly in it, and different filaments, from separate spinal nerves, communicating with each other.

The fat is not only different in different animals, but in several parts of the same, that in the thorax and abdomen being harder than the sub-cutaneous. The harder or suet is more under the influence of the sympathetic, the sub-cutaneous under that of the spinal nerves. It is probable that its enclosing membrane is furnished by the nerves of each region for harmonizing with the circumjacent parts. The scalp anteriorly is furnished by cerebral nerves, posteriorly by spinal; the fat of the face has both cerebral and spinal nerves; that in the orbit and the space behind the masseter muscle is placed amidst cerebral nerves. It is probable that the membrane enclosing it determines its quality in a considerable degree, but the nerves may also have some influence, and limit its growth, as it is in a great measure from the want of a sufficient nervous power that tumours composed of it have such an unrestrained enlargement.

Fig. 1.

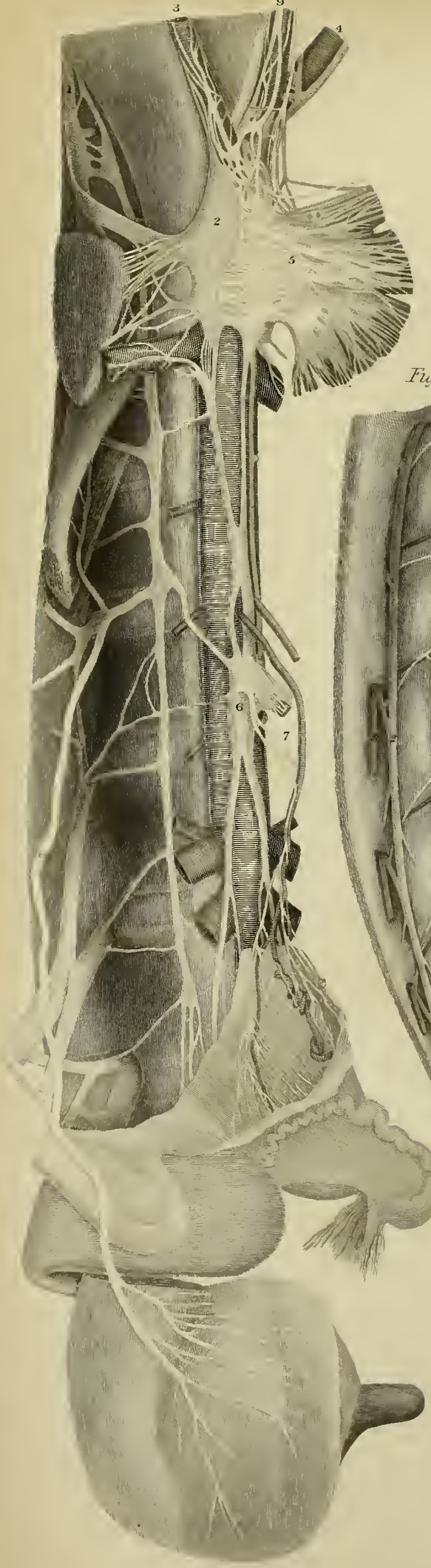

Fig. 2.

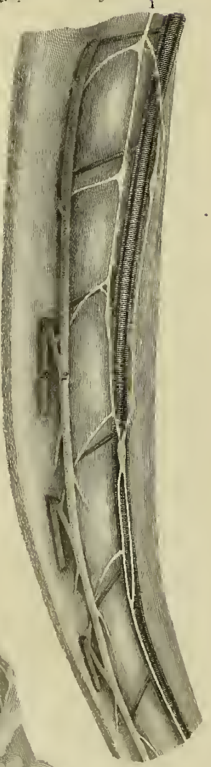

Fig. 3.

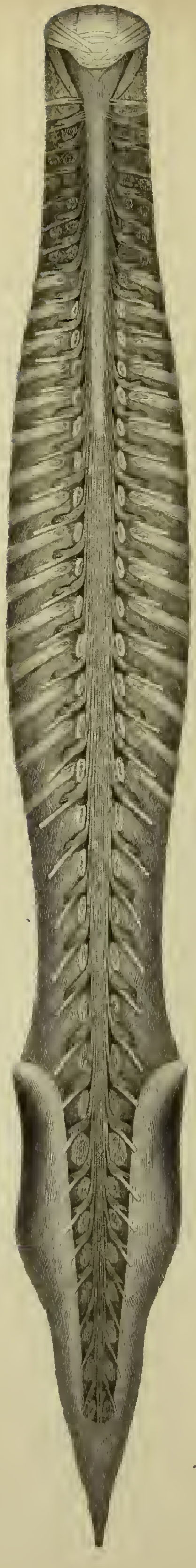

Fig. 4.

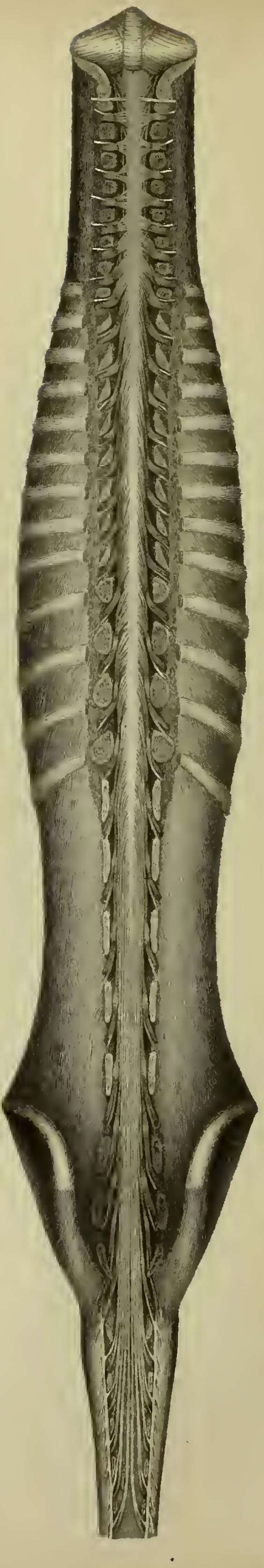

Fig. 5.

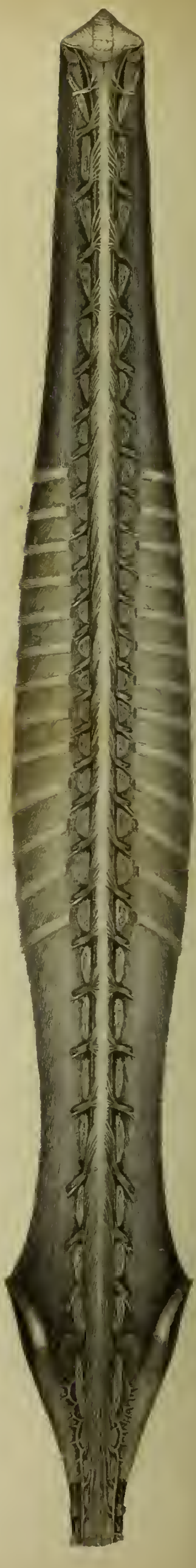

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PLATE XXVII.

THE CONNECTION BETWEEN THE UTERINE AND MAMMARY NERVES OF THE ASS.

(EQUUS ASSINUS.)

FIGURE I.

1. Splanchnic nerve.
2. Semilunar ganglion.
3. Hepatic plexus.
4. Splenic plexus.
5. Superior mesenteric plexus.
6. Aortic plexus terminating in a ganglion, which gives off the inferior mesenteric plexus, and then divides into the hypogastric.
7. Internal spermatic nerve.
8. External spermatic nerve, arising from the third lumbar nerve, and terminating principally on the mamma.
9. Branches of the posterior trunk of the par vagum passing to the cœliac plexus.

FIGURE II.

THE CAUDAL NERVES OF THE CALF.

(BOS TAURUS.)

1. Prolongation of the sympathetic nerve; in descending it is connected with the lumbar, sacral, and caudal ganglia, and, with the prolongation of the left side, forms the single ganglion about the middle of the third caudal vertebra; this ganglion gives off two branches to unite a little lower down into one, and pass with and distribute filaments on the caudal artery.

2. Anterior caudal nerve; it is formed of branches from the anterior trunks of the lower sacral and caudal nerves after they have communicated with the sympathetic; it gives off branches to the muscles and skin in its passage.

3. Posterior caudal nerve; it is formed of the posterior trunks of the lower sacral and caudal nerves, and passes down, giving branches to the muscles and skin.

FIGURE III.

THE SPINAL MARROW OF THE HEDGEHOG.

(ERINACEUS EUROPÆUS.)

The spinal marrow is short and thick, and terminates in a point about the sixth dorsal vertebra.

FIGURE IV.

THE SPINAL MARROW OF THE BABOON.

(SIMIA PAPIO.)

The thick portion of the spinal marrow extends to the bottom of the second lumbar vertebra; the point reaches to the lower part of the fourth. Many of the ganglia are placed within the spinal canal.

FIGURE V.

THE SPINAL MARROW OF THE DOG.

(CANIS FAMILIARIS.)

The thick portion of the spinal marrow reaches to about the bottom of the sixth lumbar vertebra; its point terminates in the canal of the sacrum.

The figure of the hedgehog is the exact size of the preparation from which it is taken; that of the baboon and dog have been reduced to the length of that of the hedgehog from very accurate drawings of the parts of their natural dimensions; and thus the difference of the termination of the spinal marrow and the length and breadth of the cauda equina may be accurately observed.

Besides the previous consideration of the centres and nerves, it becomes necessary to notice some points relating to their texture, the uses of the particular dispositions of the nerves, and their inherent and acquired properties.

The membranes of the brain and spinal marrow are similar, but each has its appropriate functions. The dura mater, besides its other functions, by forming a thick external covering defends the brain and spinal marrow and extends to the outer surface of the neurilema inclosing the trunks of the nerves, whilst the pia mater is continued into the cellular tissue, which contains the medullary and cineritious matter, and forms the more delicate neurilema of the fibrils of the nerves. The arachnoid membrane, by covering the others, prevents the contact of two dissimilar surfaces, but does not interest the nerves after they have left the cranium and spinal canal. The cineritious and medullary matter constitute a mass, having in some respects a general character, yet they assume a modification of texture, form, and functions. It is therefore necessary, that as the brain has both a general structure and functions, the nerves should have the same, and as it has also a particular structure and functions, the nerves connected with it require to have modifications of their structure, and to partake of the qualities of the centres in a greater or less degree, according to the circumstances under which they are to act.

The cellular tissue of the brain and spinal marrow is formed in a particular order, and the medullary and cineritious matter are deposited in it. The pia mater and this tissue originating from it make a convenient support for the blood-vessels, and form the principal seat of inflammation, thickening, suppuration, and other morbid changes. A nerve after the same manner is composed of membrane and medullary matter; the layer of membrane or neurilema surrounding the whole nerve and the larger bundles is thicker, and that intermixed with the medullary matter of the fibrils more delicate; the membranous part forms a support for the ramifications of blood-vessels, as the cellular tissue does in the brain and spinal marrow, and has a capability of somewhat similar, but modified morbid changes, as it is seldom the seat of suppuration except from the application of a ligature, or from a continuation of a morbid action from contiguous parts; it bears a much greater proportion to the medullary matter, and its texture is more dense and much less affected by putrefaction than that of the brain and spinal marrow. Many of the variations in the structure of the nerves occur in different animals, some for harmonising with the general construction and qualities of the body, others for peculiar functions. But however different the nerves may be in some respects, their membranous portion throughout is subjected to the same laws. The brain and spinal marrow and nerves of different animals vary in having a stronger or finer membrane, which contains a greater or smaller proportion of medullary matter.

The delicate cellular tissue surrounding the brain of fishes with the fluid it contains, tends to keep the diminutive organ steady in its capacious receptacle. The nerves in passing from the cavities containing the centres become invested with a thicker neurilema, and this partakes of a cellular structure more or less condensed according to the size of the nerves and the parts of the body through which they pass, at the same time that it forms a proper means of conveying the more delicate medullary fibrils to their destination. By variations of its texture it becomes also accommodated to the surrounding structures, and as the cellular membrane is the general connecting medium of almost all the other textures, so by its variation in the nerves, these are not only safely conveyed, but combined in their vital powers with every part through which they pass, and partake of the neighbouring blood-vessels, and in all probability of the absorbents and nerves.

Although the membranes of the centres and the nerves are generally similar in each class of animals, there are deviations which partake of the peculiarities of the other parts of the body, as in the colour of the skin and hair, the pigment of the eye, and in various modifications of texture and composition, which are not generally appreciated; these differences may be more or less connected with a delicacy of structure and a particular perceptibility of atmospheric changes. Most commonly a nerve is a white glistening chord, but has sometimes a tint inclining to yellow or blue. In the pelican, the nerves supplying the beak are covered with a black membrane. It has different colours in invertebrated animals, and is not always similar in the same species of the vertebrated, but varies like the black or dark pigment in the membranes of the brain of some sheep. Almost the whole nervous system of the crocodile is enveloped in the same black membrane. This variation shows that as the internal parts of the nerve are white, the external covering and that inclosing the fibrils are not required to be precisely similar, and therefore that it is an adventitious production and connected with some peculiarities of the animal.

There is a great variation in the texture of the component parts of very numerous animals, and as the nervous system and especially the nerves must be connected with them, so a proportionate degree of firmness or softness is required. Many nerves have therefore been constituted with a view to the mechanical operations in which they must be involved. In those animals, in which all the organs have a softer texture, the nerves have a participation of the same consistency, but although they are generally strong in powerful animals, some of them which are well protected and are required for particular functions, preserve in a considerable degree the similarity to the tender fabric of the brain.

In mammalia and birds, a nerve is fibrous and strong; but there are exceptions, for in the pelican it is generally soft and approaching in some degree those of fishes. Several nerves have a different character in the same animal, and particular ones do not correspond in every class. In mammalia, birds, and fishes, the olfactory nerve is reddish and soft, but in amphibia is strong, fibrous, and coarse; the optic nerve is not so fibrous, and although soft at its beginning, it is white and becomes firm and strong after it has entered the orbit, and lays aside this assumed character on its expansion into the retina; the auditory is fibrous and soft, but in fishes is more like the other nerves in texture. The fifth is generally a fibrous and strong nerve like the spinal, and in some animals is very coarse, but more particularly its second trunk; it is, however, doubtful whether there is a less proportion of medullary matter to the neurilema, or only larger fibrils, as those of the second trunk of the fifth, which are very large in the horse, had a beaded appearance from a rupture of the neurilema, similar to that presented by the spinal marrow from an exudation of the softened medullary matter. The texture of the nerves of the muscles of the eye, the hard portion of the seventh, the glosso-pharyngeal and the par vagum, are composed of strong, but fine or slender fibrils. The sympathetic is generally more pearly or transparent than the other nerves, but not always, and is made up of coarse or fine fibrils more or less closely put together, and has not so thick a neurilema. In turtles and snakes the nerves are generally rather softer than in birds, but still have considerable tenacity, and they are tortuous and elastic in the snake, particularly about the fauces and the ventral aspect of the body. They appear to be softer in the cod-fish than in the turtle, and in the skate than in the cod. In fishes some of the nerves acquire a very remarkable increase of size even close to the brain, which may be derived partly from the surrounding delicate cellular tissue. In the lobster the nerves are less strong than in cartilaginous fishes, and in the crab than in the lobster, and so transparent as to be with difficulty distinguished from the muscles, except by their smoothness, until they have been immersed in alcohol or some other fluid. The same nerve varies in different kinds of animals, and is modified to the structure as well as the functions of the organ receiving it. In animals, nerves similar to those in man are distributed over the body, and are larger or smaller according to the varying size of each organ, and become adapted to its structure through modifications of the neurilema, the medullary fibrils preserving the character of the brain from which they originate. Both the medullary matter and the neurilema are therefore varied in several nerves of the same, and the corresponding ones of different animals, their greater or less strength depending on the neurilema.

If nerves had been altogether passive, they must have been very long for their adaptation to moving parts, and very inconveniently placed amongst them. As their medullary portions will not bear either extension or pressure, they require a particular construction. The medullary fibres have generally a tortuous appearance, whilst surrounded by the neurilema in an animal recently dead, and become straight by extension, and tortuous again by relaxation ; there is an elasticity of the neurilema, but not in the same degree of the medullary fibres, the elasticity allows a nerve to be extended with the surrounding structures and shortened with their relaxation, and thus to become accommodated to the changes of position caused by the motions of the body. An uncommon elasticity may be observed in the nerves of the human body after they have been preserved a considerable time, but it is not certain whether a previous commencement of putrefaction may not have been the cause. In the jaguar there is a great elasticity of some nerves, particularly of those of the pharynx and the sterno-hyoid and sterno-thyroid muscles; it is very little in those of the tongue or in the par vagum and accessary of the same animal. There is a tortuous appearance of the numerous small nerves in the very extensible parts of the snake ; it is produced by connecting processes of the surrounding cellular membrane, which in returning to its contracted state after extension draws them into folds, and by this contrivance they are easily elongated when the body is in motion, or distended with food. The tortuous state of the medullary fibril, depending on the neurilema, and that of the whole nerve on bands of surrounding cellular membrane, answer similar intentions.

In a few instances, nerves having different functions sometimes do not exhibit the same appearance. The circumstances under which death took place may have influenced the quantity and colour of the blood in the vessels. Much caution is necessary in drawing conclusions from this source, as a very little extravasated blood will tinge both the nerves and ganglia ; so that on a superficial observation, it may be supposed that an increased vascularity existed : but on examination with a magnifying-glass, the blood is found to be diffused, and not contained in vessels. The spinal marrow, and a considerable length of its nerves, after a preservation for some years, had acquired a red tinge from the materials with which the arteries had been injected. The nerves may assume different colours from the transudation of various juices ; it is therefore necessary, for any particular observations, to remove them soon after death, without wounding the surrounding blood-vessels and viscera.

The functions of the various organs of the body are dissimilar, and there are modifications of corresponding ones in each class, and in almost each species of animals; so that there is necessarily some difference in the origin and distribution of the nerves supplying them, which is sufficiently great for concluding that the different portions of the brain and the nerves originating from these have peculiar powers. Although some parts of the centres prescribe the general functions, many particular ones are completed by the mode of ramification, communication, and termination of the nerves, the disposition of the accompanying blood-vessels, and the structure of the organs, and the uses to which they are subjected.

Each nerve acquires its particular faculty from a difference in the parts of the brain giving origin to it, and in those having the same properties there is a similarity of origin, as in each surface of the spinal marrow. The difference between the olfactory and optic is sufficiently remarkable, but they are constructed according to their required purposes; for scents are less readily perceptible than light, and the portions of brain giving origin to the olfactory are softer, and contain a much greater proportion of cineritious matter in those animals, at least in which they are large enough to be well observed. A particular state of the nerve and the portion of brain from which it arises, is requisite for allowing the required impressions, so that the olfactory would not produce sight, nor the optic appreciate scents. But besides the state of the nerve and its origin, an appropriate organ is necessary for receiving it; so that the brain must be approached in its own way. The investigation of the origin of the nerves may be carried on in the recent parts with some success; but their precise limits cannot easily be determined. When the medullary matter has been removed, the filaments may be traced to their connexion with the cellular structure. Comparative anatomy has very much simplified this inquiry; for as nerves, corresponding to those in man, exist in several classes of inferior animals, and have the same principal functional quality which determines the sense or action, it may be concluded that the primary parts of the brain giving origin to them are similar, but generally not very extensive, and that the additional ones enlarge their powers, as is done by the connexion with larger or smaller thalami, striated bodies, and other parts.

The nerves themselves are not mere conductors of some particular influence, but take a considerable share in the completion of the functions carried on between the organs receiving their terminal filaments and the brain. Several just after their origin are mere threads, which partake of the simple qualities of the centres, but by their interchanges, more or less intricate combinations are effected according to the required functions. The modification of some of them is begun before they become included in the process of dura mater at their exit, as in the formation of the bulb of the olfactory nerve and the commissure of the optic. After they have acquired an investment from this membrane, they proceed towards their destination, either without further change, or their fibrils become more or less intermixed, and combined in bundles by the neurilema, and form larger or smaller trunks. The nerves of the brain, except the fifth, are of such a size as not to require any division before their ramification for distribution. All nerves have not either the same texture or appearance after the neurilema has been separated and their fibrils unravelled, but these are combined and intermixed differently in separate nerves, and more or less in various parts of their course. Similar nerves exist in each region of the body throughout the several classes of animals, and it is probable that the mode of communication between the fibrils of many corresponding ones of different animals is generally similar, but varied in some degree, according to their required functions, as for the more or less combined actions of the muscles, the form and other peculiarities of the several organs. By leaving the fibrils of a nerve unconnected the parts supplied are more independent, in the same way as the muscles of the eye are by the distinct origin of their nerves. Some nerves are joined together by neurilema only, as in the peroneal, which runs nearly the whole length of the thigh, without communicating with the sciatic. When the neurilema has been separated, and a nerve resolved into its coarser fibrils, the threads of each of them are also found to have combinations with each other, and to be connected by a finer neurilema. Nerves are of different sizes for particular purposes. A large nerve not only conveniently receives several smaller ones, arising from the spinal marrow, but passes more safely through the midst of parts having powerful motion ; it must not however be too thick for bending, nor too weak and slender for withstanding the necessary action. The smaller branches, for their safety, must be sufficiently long for allowing the increase and free action of the muscles, which they must enter at a convenient place, so that they may be drawn out of their course as little as possible. When the fibres of a muscle are nearly parallel, and therefore liable to be much shortened, if a nerve enter it near its middle, one portion will retrograde to the upper part whilst the other descends to the lower, or it may be supplied by different branches. In the single penniform muscle, or others in which there is not much shortening, it may enter near the upper part. One nerve is sufficient for an extremity, in which the motions are limited ; but when these are more complicated and extensive, a disposition is required by which there may be a division into several branches, for their yielding with the moving parts. Very thin nerves, if sufficiently long, and loosely connected, pass easily over structures having considerable motion. Nerves may be thick and narrow in some parts of their course, and flattened when they pass between powerful muscles, or over hard surfaces, or underneath broad ligaments. Corresponding nerves of different animals may be longer or shorter, according to the length of the parts over which they must be conducted to their destination; but their specific functions are not thus altered, as the power of the whole nerve is generally in proportion to the aggregate quantity of fibrils, and not to the length or breadth. The optic nerve, which traverses a considerable space before it reaches the eyeball, and the par vagum, which has such an extended course in the long necks of some animals, have not any additional powers.

The ramification of nerves must be effected with some precision as to the place and manner in which any separation is made for the appropriate connexion with the blood-vessels, and several other parts, and especially those admitting of changes during active exertion, or during their more passive condition under the influence of the organs placed in their vicinity. A nerve may divide into many or few branches, but provided the angle and direction at which they proceed be favourable, this appears to be a matter of small importance. Some nerves ramify in a particular manner on account of their softness, their situation, and the connexions they are to form with other structures. Therefore a varied contrivance is necessary for the safe conduct of the same nerve in different classes, although their functions are similar. In man and mammalia the olfactory nerve passes in branches through many distinct foramina in the cribriform plate of bone, but when it is not very large, or can conveniently and safely reach the Schneiderian membrane as in the goose, or when it is strong as in amphibia, there is not a cribriform plate for its fibrils to pass through; when it forms a soft ganglion, as in mammalia, and the skate, there is a bony cribriform plate in the former, and a membranous one in the latter. The second and third trunks of the fifth generally go through separate foramina in mammalia, but in birds, amphibia, and some fishes, both pass through the same. Some branches of the fifth in various parts of the face are conducted through foramina in some animals, but not in others, and several, instead of passing through one, pass through many on account of supplying parts which have different forms and uses, and so with respect to nerves in other regions. Great importance is too frequently attached to nerves contained in osseous channels, and therefore traced with considerable difficulty, but these are only differently placed for safety on account of their slender form and their peculiar destinations.

When numerous parts are to be supplied by the same nerve, and particularly when it furnishes organs which are different in structure and function, it is a matter of considerable importance that its branches should be given off in such a manner as will preserve some of the several fibrils of the trunk from being too much involved with the rest, and prevent their being influenced on every occasion with all the organs it is connected to. The previous division into branches tends to make each portion supplied more independent than if it had divided only just before its termination. From a large long nerve the branches generally pass off at a considerable distance from their termination; this however may depend somewhat on the motion and other properties of the part supplied. Nerves for particular faculties may be continued undivided until they are about to terminate, as in the larger portion of the median and ulnar for supplying the skin on the anterior surface of the fingers, in the plantar, and in the nerves of the nose and lips. But to the skin generally, the nerves proceed either in small trunks from their origins, as the intercostal, or in small long branches from larger trunks, and the terminal filaments form a more continuous web than those of the papillæ of the fingers.

A branch of a nerve, although partaking of the same nature as the rest of the trunk from which it originates, by its mode of distribution becomes independent to a certain extent, so that a nerve may have a very lengthened course, and supply various organs, and yet the functions of each of its branches not be interfered with by the rest. The extensive distribution of the par vagum may be taken as a very good example of this. A single branch becomes independent of the original nerve in proportion to the manner in which it is separated from it, and to the number of times in which its various filaments communicate with each other in their course to their termination. The hard portion of the seventh forms several larger divisions, each of which separates to some extent the regions it furnishes, and by the greater or less plexiform disposition of the ramifications of each of these divisions, the parts supplied are more or less independent, or associated in action.

When a nerve has reached the organ destined to receive it, it is usually considered as having arrived at its termination; but although in many instances it be hid from the further scrutiny of the anatomist, it is probable that other properties, and these as important as any that have been yet adverted to in the economy of the nerves, become developed. As in those instances in which the transparency or other favourable disposition allows of an examination, a difference in texture and arrangement is observed, it is therefore probable that this is continued in a varied state for the several structures, but modified in some degree for the particular functions attached to each.

The mode of termination of a nerve, as well as its origin, has a considerable share in defining its functions; in some instances the arrangement of the terminal filaments conduces to their completion, but in others principally the form and structure of the parts receiving these. The termination approaches to a membranous expansion in all animals, and is more or less soft and fibrous, and at length lost by becoming interwoven with other structures in which it cannot ultimately be distinguished. It may indeed be seen to some extent in parts of the Schneiderian membrane, the retina, the cochlea, the surface of some of the muscles and blood-vessels, the papillæ and the inner surface of the skin, in those animals in which the skin is thin, delicate, and free from fat. Although the nerves form a membranous expansion, it is probable that this is connected with the structures receiving it with some regard to the shape and mode of insertion of the terminal filaments. When through a mechanical stimulus certain physical properties are to be impressed on the sensorium, a more particular form of termination is necessary, but when a considerable breadth is to be supplied, the more general thin and delicate membranous character prevails. It may be readily conceived how impressions may be better received in some forms of nerves rather than others, or that a peculiar arrangement of both nerves and arteries, or of the shape of the secreting point of each organ, may be required for promoting the different secretions; but it can only be conjectured, how the nervous essence issuing from terminal filaments, even if these are of determinate shapes, becomes impressed so as to influence the blood directed through arteries peculiarly and appropriately arranged for each secretion. When a nerve passes to a part without much communication with others, it will convey one of the most simple perceptions, and this will be well adapted for appreciating the difference of solids, as in the points of nerves terminating in the papillæ of the fingers, and in a modified degree in the tongue, lips, and nose of many animals. But the more extended and connected dispositions which exist for the skin generally, are better fitted for appreciating diffused perceptions, as those from the atmosphere with respect to heat and cold. A further modification is made in the auditory nerve concentrated in the labyrinth, and a still greater in the uniform expansion of the optic nerve in the retina.

The same nerve varies in size in different animals according to the magnitude of the parts it supplies. In some instances it is not the whole nerve, but one or more branches in particular, which assume a magnitude truly surprising, as in the mylohyoideal branch of the pelican compared with the same in the goose, and this on account of the extent of the parts it supplies. When an entire organ is wanting, there is a deficiency of its nerves. When some parts only are wanting, there is an abstraction of a portion of a nerve. In birds and amphibia, the muscles of the face and lips are absent, and a part of the hard portion only which corresponds with the digastric division exists; besides the upper belly of the digastric muscle and one compared with the stylo-hoyideal supplied by it, only some slender slips of muscle attached to the skin are found in birds. Where muscles are present, but are more combined in function as in the pelican, the various nerves exist but are more or less conjoined.

The brain, or any part of it insulated from the nerves, cannot of itself direct the performance of the animal functions, for without a nerve peculiarly formed, its influence is not communicated to organs, and does not receive any impressions from these. A nerve is not only necessary, but it must be adapted to its required destination by undergoing some changes of structure. A simple nerve is sufficient for a simple function, as in the fourth for supplying a single muscle; so also in the third, but if one of the branches of this enters the eye, it is frequently more or less changed through a ganglion, that it may be suited to the different structure. As the organs become more complicated, other nerves are also changed according to the required state in the economy of each animal; hence the variations of ganglia and plexuses, and the distributions of the arteries and veins, and the peculiarities of form of different parts.

There is a great variation in the structure of the skin, not only in each class of animals, but in different kinds of the same, so there are also some variations in the structure and disposition of the nerves. Most of the sensitive nerves are coarser than the motive, and become expanded in ganglia, but the motive are not so changed except when their functions are complicated. Some of the nerves of the special senses have ganglia, which are different from any other; the olfactory is soft and reddish like the cineritious substance of the brain, and the optic is joined by its fellow in a commissure, which may be considered as somewhat similar in structure to that of the olfactory, it is however white, like the medullary substance of the brain, but a ganglion exists only in the olfactory and optic of some animals, as well as in the ciliary, gustatory, and sympathetic, and sometimes in the chord of the tympanum, and is therefore necessary for modifying the functions of the nerve. The ganglia may be simple and thready, or they may have nearly the same texture both in the sympathetic and spinal nerves of each animal. They do not observe the same form of structure in the different portions of the nervous system of any entire class.

The fibrils of a nerve are more or less combined on entering a ganglion. When either new or modified properties are to be imparted to the nerves, they become incorporated with each other, or have the disposition of their fibrils altered in ganglia, and these vary in structure in several parts of the body according to their required uses; the corresponding ones of animals vary according to the peculiarities of each individual. Ganglia exist as centres of origin or connexion of nerves from, to, and through which impressions proceed, but the fibrils of the spinal undergo some changes of arrangement, which in many instances are very slight. They combine and harmonise different nerves, or allow a large one, as the splanchnic, to be diffused in a wider centre, giving it a firm attachment in a convenient situation for furnishing the very numerous branches to the viscera, whose extent and varying condition require a peculiar distribution. They may in some animals, or several parts of the same, effect greater or less changes according either to the complexity or simplicity of arrangement of the fibrils of the nerves entering them, or to their more or less close structure, and the quantity of the red intervening matter; they may, therefore, be very slightly varied as to their constituent parts in many instances from the nerves entering them, the disposition of the fibrils being merely altered, or they may be entirely changed, no vestige of the fibrils remaining.

In some ganglia of the sympathetic nerve, the nervous fibrils are obliterated in their close solid substance; and the perceptiveness of organs supplied by their branches is of a peculiar kind, and conveyed with some modification to the spinal or other communicating nerves. When the fibrils are not entirely obliterated in the ganglionic matter, there is a difference from the preceding state, inasmuch as the perception of the organ receiving its branches approaches nearer to the cerebral or spinal nerves, and when the ganglion has almost entirely the form of a plexus, the approximation becomes still nearer. So in the ganglia of the spinal nerves, the greater the quantity of new matter in which the fibrils of the nerve are subdivided, the more the perceptive faculty is modified. The more thready a ganglion in which the fibrils of a nerve communicate, the nearer the perception approaches that of the naked spinal marrow, but this may make the sense of touch less delicate, or the perception of cold less acute. When a ganglion is entirely thready, as in the sympathetic of the snake and turtle, the plexiform structure modifies it to the state of the organs supplied, for each of which there exists a different disposition.

The nerves have an altered action after they have entered a ganglion, but less when it is thready than when solid or fleshy. That of the thready may vary according to the intricacy, the number of filaments of which it is composed, and the frequency of connexion, and in the same manner as in plexuses increase their power, but a nerve undergoes a less decided change in the thready ganglion than in the close and fleshy, which has therefore attributes almost entirely new and peculiar to itself. It is probable that the more extensive the ganglion, the greater is the increase of accumulated power in proportion to its size.

By means of a series of ganglia similarly constructed, an extensive surface like that of the skin supplied by branches issuing from them, has a similar and more uniform perception throughout, as well as most of the muscles, bones, and other parts of the trunk. This arrangement may accommodate the nerves more perfectly to the required state of the skin; it may also make a smaller portion of the brain necessary for allowing a cognizance of the whole, and the attention not so easily diverted from the various pursuits by too many distinct points of communication. The gasserian ganglion ministers to the organs of the senses, and the several parts of the head and face, which are in many respects similar to the spinal nerves in the trunk and limbs, but it differs from the spinal in structure and quality as it does in its modified functions.

The perceptive power of all the spinal nerves of each class of animals is nearly equal at their origins, but is modified by the structure of the ganglia, and the parts supplied in different regions. The arrangement of the fibrils entering the ganglia of the spinal nerves is more or less altered to the required state of the skin, and the necessity for their participating in the peculiar attributes of the viscera, so that the animal may keep to such a situation as will be agreeable to the feelings of the external parts, and tend to preserve the internal ones in a healthy condition, and also lead it to the places where its proper food is abundant. As the structure and functions of the skin and viscera vary, a modification is sometimes required in the ganglia, both of the spinal and sympathetic nerves in the same animal.

When a fractured vertebra has pressed upon the spinal marrow, so as to insulate the lower portion, and destroy entirely sensation and voluntary motion, the principal functions of the sympathetic nerve continue, as well as certain inherent powers of the spinal marrow. As in health, and particularly as regards pain, the sensitiveness of the sympathetic is not the same as that of the spinal nerves, it is not improbable that the ganglia of the sympathetic have the property of changing the perceptive faculty and modifying it according to the close or open condition of their texture.

Nerves are different at their origins, but undergo changes before they reach their destination, not however precisely the same in all animals, as they require to be suited to all the parts with which they must be in different ways connected. New centres have been formed through ganglia communicating with the great ones, and these are larger or smaller for supplying the organs required for the changes necessary in the economy of each animal for its particular destination. Ganglia exist in invertebrated animals, and differ very little from the brain; their convenience is particularly shown in some of those animals in which there is so much variation of form and structure; they have the faculty of harmonising a nerve to each of these changes, or of extending the same influence more conveniently to a distant part without the incumbrance of too large a centre in one spot, so that a nerve sent from the principal ganglion will allow the motion and free action of the various parts over which it passes to the place where a fresh ganglion can be conveniently situated. With some exceptions they are present in each division of the nervous system of the other classes. It is probable that their place can be better supplied for particular purposes by other contrivances. They do not exist in the cod-fish, it may therefore be presumed that the communication of each nerve with the neighbouring one, together with the posterior branch of the fifth, forms a more suitable combination of the whole after so extensive and complicated a distribution.

A plexus, which is in the place of the similunar ganglia in the turtle, also in the snake and crocodile, is regarded as belonging to the thready ganglia. The arrangement to be generally considered as a plexus in various parts of animals, is in much wider meshes, and therefore with less frequent connexions of the nervous branches. The more intricate these are, the nearer they approach the functions of ganglia. All the intermediate changes are connected with the altered functions, which are modified either in keeping up a more concentrated exciting power, or a greater or less communion with other nerves. Ganglia are formed for altering the condition of any nerve, according to the texture they assume. So nerves require other changes in plexuses; these may be considered as a modification of ganglia, to which they are in some degree subservient, for they are frequently placed as the first arrangement of the branches proceeding from ganglia to their destination. It is not however necessary that plexuses should proceed from ganglia; for without these they may at once implicate one or more nerves with each other, which they can alter or combine in function.

A modification of a ganglion is in some parts produced by various forms of plexuses, and nerves are thus dispersed over a large surface for the convenience of furnishing branches to different organs, which vary in size and situation. In the four superior classes, separate plexuses have more or less intricacy, which is generally the greatest in those of man; but in this respect they may be equalled if not surpassed in particular parts of some animals. A plexus may associate several branches of the same or of different nerves. It does not prevent each separate nerve from actuating any part for a single purpose, whilst it combines several for a more general and complicated operation; a peculiarity of arrangement must however be adopted for this purpose.

A plexus changes the form of a primitive nerve, and modifies it according to the peculiar disposition and number of fibrils of which it is composed. It is not always a mere division into numerous smaller filaments, as these when combined would greatly exceed their primitive branches in magnitude. It may be constituted of one or more branches of any single nerve, whose functions will be modified according to the form and interchange of their fibrils. It may be composed of various nerves for producing a consentaneous action throughout a complex organ, and also for associating it with other parts supplied by each of the same nerves. According to the greater or less complexity in the mechanical disposition of the filaments contained in it, will be its faculty of accumulating power, and according to its mode of connexion with a few or many branches, either from primitive nerves or neighbouring plexuses, will its powers be diffused or circumscribed. Thus in the semilunar ganglia and cœliac plexuses, its numerous connexions will effect a great sympathy or consent between several of the viscera. If it be insulated and very complicated, and one or two primitive branches only enter it, when it is in an excited state, very little of the action will be conveyed along the primitive branches to the ganglia, or nerves, from which they have originated; or, to make it more plain, the stimulus will produce an effect many times greater in the plexus, when it is divided into numerous filaments, than in the nervous centres connected with it by the one or two primitive branches; so that whilst the stimulus is circulating along the many filaments in the plexus, and producing an extraordinary and concentrated action and an increased flow of blood, it will only be slightly propagated along the one or two to the nervous centres.

Plexuses are so formed that only some portion of them may be brought into action by any part of the organs requiring to be excited. It may be presumed that the will is sufficient for this purpose, so long as the muscles are concerned, as in producing the action of some of the muscles of the face through a part of the plexus of the hard portion, or a single muscle or joint through the axillary or sciatic plexuses, or in different portions of the pharyngeal plexus; and for other plexuses it may be presumed, that although organs receiving the terminal branches may have some influence, it is nevertheless required that there should be a peculiar arrangement of the nervous filaments for giving each plexus its functional properties as well as for combining and separating it into greater or less portions, according to the extent and number of the organs supplied.

Plexuses exist for associating various organs, for concentrating nervous power, according to their extent and complexity, and for accommodating nerves through the safe but yielding support or conduct of blood-vessels to organs, and particularly those loosely situated, and liable to changes from emptiness to fulness.

The functions of a plexus are modified by the accompanying blood-vessels; the separate functions of the division of a large plexus are however limited, not only by diminishing the number and disposition of the blood-vessels, but by the peculiarities of the organs which receive the terminal filaments, and the manner in which these are open to excitement. The liver is almost compelled to its extraordinary functions by the increased quantity of blood sent to it during digestion, and the secretion of bile taking place from venous and not from arterial blood. The kidney is stimulated beyond its usual action if the blood contains an inordinate quantity of the matters requiring to be excreted; or, if it be irritated from a great influx of blood, when other secretions are stopped. The increase of the uterus depends upon the presence of the living fœtus, and the continuance of the size and functions of the mamma on the extraction of the milk. These facts show that the nerves and blood-vessels alone, even when their excitement has existed for some time, and the peculiar arrangement of plexuses, are not sufficient for the continuance of action, but that a particular stimulus is periodically if not perpetually required, and not only in these organs but in almost every portion of the body.

The pharyngeal plexus is composed of different nerves, which allow either the whole pharynx to act for one effect, or separate parts of it to be associated with other organs, to which its several nerves are related. The cardiac plexus is very independent, so that the stimulus arising from its action will extend very little to or not beyond the ganglia, from which its primary nerves issue. The stomach, by the disposition of the branches of the par vagum, is made in some measure independent, although these nerves form communications with the cœliac plexus. All the other chylopoietic viscera are supplied by the intricate cœliac plexus proceeding from the one or two splanchnic nerves; so that whilst a limited connexion is thus made with the prolongation and ganglia of the sympathetic, a new and extensive range is opened for associating the numerous viscera. Notwithstanding the intricacy of this plexus, and the great communication it makes between the organs supplied by it, the several individual or subordinate plexuses derived from it, by their peculiar and appropriate disposition, have their functions confined within certain limits; so that although there be such a consentaneous action between the liver, spleen, and intestinal canal, there are nevertheless, through the disposition of their plexuses, some limits set to their sympathies. The quantity and quality and mode of supply of blood, and the secretions and substances traversing them, also exert a considerable influence. The superior mesenteric plexus is resolved into numerous longitudinal threads, communicating more or less with each other, and surrounding the superior mesenteric artery. Each of these threads is directed to a particular portion of the intestines, so that irritation may be actively ranging through the ramifications of one of them, whilst it is more slowly communicated at each extremity of the affected part to neighbouring ones. In this manner each fœtus in the long horn of the uterus of an animal producing several at once, is in some measure independent of the next, whilst in all of them, through an equal distribution of the same nerves and arteries, a regular and similar excitement and action are maintained.

The several plexuses vary, not only for the particular necessities of each organ, but for the corresponding ones of different animals; and when it is considered that there are variations of the viscera as well as of the shape, constitution, habits, and nourishment, in numerous instances, it can only be concluded that each disposition of the nerves is intended to harmonise with the several qualities: so that whether in the cardiac or the hypogastric, which are concerned almost entirely in the motion and sensation of the parts they supply, or whether in the cœliac, which besides the preceding powers, are very much connected with the nutritive functions, the form of the plexus is peculiar. The plexiform disposition may be principally concerned in combining together all the parts of the organ, without altering the functions of the terminal filaments.

In invertebrated animals some communications exist between the different nerves; but plexuses are seldom required, as the ganglia modify the constitution and functions of the nerves, and preserve all the necessary combinations and sympathies. The ring of the crab connects together all the legs, and the separate ganglia those of the lobster.

Plexuses are formed in the spinal nerves for associating in action the several sets of muscles, as the axillary in the upper extremity and the sciatic in the lower; sometimes, however, a single nerve exists instead of the axillary plexus. They also exist for associating some cutaneous nerves in the pelican. There is a necessary order observed with respect to the nerves entering the plexus, inasmuch as all of them do not communicate equally with each other, but so as to produce particular associations in the parts supplied by the branches sent off. Plexuses are not necessary when there are many legs, as in the lobster and centipede, but only when there are many muscles for a single limb, which has extensive and complicated actions. After the combination in a plexus, the nerves do not seem to have acquired any fresh qualities, as in promoting flexion, extension, abduction, adduction, or any other motion, for one portion of the principal nerves of the lower extremity is directed to the anterior part of the thigh, as the anterior crural, another to the internal, as the obturator, and a third to the posterior, as the sciatic; this last is again divided into the peroneal, principally for the extensors of the foot, and the posterior tibial for the flexors and skin. All of them are however formed and distributed in a particular order for preserving a clear connexion with the brain. Muscles perform their requisite functions according to the direction of their fibres, and their mode of insertion through similar nerves. One set of muscles put in action by the will has a tendency to excite the antagonists and their nerves, and after a few trials, to continue these alternate actions, not improbably through the influence of the cerebellum, until they are arrested by the will. If it were necessary for the will to be continually directing the larger muscles in walking and similar exertions, it could not at the same time be free for other purposes; but when very nice movements are to be effected, and especially at first, its attention must be continually directed to them. For securing a determinate action of hollow muscles, the chief calculation has been respecting the results of peculiar directions of the fibres, and their mode of concentration and attachment, rather than upon any difference of the nerves, except as far as these are conveniently disposed. In a hollow viscus the shorter fibres will generally be first stimulated by the contents, and when these have been extended a certain way, the longitudinal ones feel the distension, and are brought to assist the others in their propulsive action; both, however, may act together, independently of distension, under sufficient irritation of the lining membrane. There are different nerves for hollow muscles, as the par vagum for the œsophagus and stomach, the sympathetic for the intestines; the nerves have peculiarities according to their origins, but the separate action of different planes of muscular fibres does not depend upon the difference of the nerves, but upon the disposition of the fibres. There are mixed nerves for the bladder, but these supply the whole: the sympathetic portion does not belong to some fibres, and the spinal portion to others.

It may be a question how intimately the nerves, destined for the muscles and skin of any circumscribed part, as the anterior and posterior bundles of the spinal nerves, are intermixed with each other, and have their functional qualities united. Between the branches of the hard portion and the fifth, there is a considerable variation in different animals; in some the combination is in a greater or less degree, whilst in others, the branches pass separately to their destination. In most of the spinal nerves the anterior and posterior bundles become so intermixed, that it is very difficult or almost impossible to separate them again; and although it is supposed that the fibrils of each of them pass in a considerable degree to their termination with their separate functions unaltered, it is nevertheless most probable that, by the close combination effected between them, some filaments at least partake of the conjoined structure and function; the muscles are therefore more perceptive than they would have been without the sensitive nerve, and the skin has a greater degree of tone and contractibility than it could have possessed without the motive nerve, and only a little less than that imparted to the cutaneous muscle; so that all the parts supplied may be associated in action, but in a greater or less degree, as in respect of the fifth and hard portion, according to the peculiarities of the animal and the required functions.

Great care has been bestowed not only on the adaptation of all the parts of an animal to each other, but for securing the regular performance of their functions, by preventing as much as possible their dependence on exertions of the intellect. The more limited the instinctive faculties, the more carefully have means been provided for directing them by unalterable mechanical contrivances, as by the course of the muscles and tendons, the forms of the bones, ligaments, and thickened integuments. Even when extensive motion is allowed, parts may be brought towards an automatical action by a habit of exerting particular muscles, and although the voluntary power over them remains, there is some difficulty in changing entirely their acquired direction.

There are simple conjunctions of branches of nerves for keeping up a consentaneous action in a large surface, as in the head, face, and other parts. There are apparently simple but intimate conjunctions formed between several nerves having different functions, as the fifth and hard portion of the seventh, the fifth and almost every cerebral nerve, and between the fifth and all the spinal nerves in the cod. Between many different ones in the neck of the pelican, in which there are combinations of the fifth, the hard portion of the seventh, the glosso-pharyngeal, the par vagum, the ninth, the spinal and sympathetic nerves. Between the sympathetic, and both cerebral and spinal nerves. Many particular ones occur besides these. If nerves communicate in a different manner in animals, it is for modifying their functions to correspond with those of the organs they supply; they are varied according to a particular law, so that when there is a very material difference of arrangement of structures in which they terminate, as in the throat of the pelican, confusion may not be the result; and in animals whose feet terminate in a single toe as in the ass, there are the same nerves which supply all the toes of others concentrated in this. A direct or indirect connection exists between almost every nerve of the same side of the body, either for particular or general sympathies, that there may be a concordance throughout; but nerves of the opposite sides seldom communicate, except some of those supplying single organs and several of the viscera.

Ganglia and plexuses may connect together various neighbouring or distant organs, but several of these are associated through the brain and spinal marrow, as well as the sympathetic nerve. Through the peculiar forms of the organs, the various impressions are conveyed to the centres and mind, by which either at the present or a future time sensations may be reproduced as if they were realities; they may also be combined in different ways; or the remembrance of a particular scent, object or sound, may through the mind affect distant organs, as the stomach and others.

The doctrine of sympathies, although of considerable interest, can only be just adverted to in connexion with the functions of plexuses. To trace it through its intricacies would lead from the most simple to the most complex state of the nerves from the beginning of life.

Notwithstanding the particular forms, texture, and qualities, both of the centres and nerves, many functions of various parts of the body are promoted in a considerable degree by the arrangements of their different structures. Every nerve is liable to be excited both through its centre and the organ receiving its terminal filaments; through a direct or indirect connexion with other nerves, and the parts some of these are distributed to, but particularly through the sympathetic; it may also be influenced by various contiguous structures. The effect of excitement on a portion of the brain may be communicated through the par vagum to the stomach, or from this to the brain; the stomach may also be affected through the communications of various nerves with the sympathetic and par vagum, as of those supplying the skin and other parts, and more directly through communications of branches of the sympathetic supplying the intestines and other viscera; the shape and arrangement of the muscular fibres, and the lining membrane, determine in a considerable degree the completion of the functions of the organ, and these are influenced mechanically according to their distension as well as through the nerves. Excitement in the brain will cause the bladder to contract, also cold applied to the skin; excitement may be conveyed to the spinal marrow and the ganglia of the sympathetic nerve from the lining membrane irritated by acrid urine, also by distension of the muscular fibres and nerves; the particular direction of the muscular fibres determines the mode of contraction according to their extension.

For the functions of some parts, a more simple form of nerve suffices, or if it undergoes a slight enlargement, it is hardly to be compared with a ganglion; such a change is found in the nerves of some animals only, and is required for modifying its functions in a slight degree. The changes, therefore, to which a nerve may be subjected, after it hath left its origin, is no decided proof of its general functional qualities, but only of a modification of such particular ones as the ganglionic disposition may have produced. Either with or without the intervention of ganglia and plexuses, a nerve may possess a compound faculty, as the par vagum and glosso-pharyngeal, and although there be no apparent difference in the fibrils composing it, it is probable that each sensitive or motive portion has its distinct and separate origin, and can perform its individual functions to a certain extent independently of the other; and their intermixture on leaving the brain, like that of the anterior and posterior bundles of fibrils of the spinal nerves, either in the cod-fish without a ganglion, or in other animals beyond the ganglion, allows the manifestation of separate faculties, but produces a modification of both. Nerves may be conjoined in various ways for particular purposes ; the ninth alone is sufficient for some muscles, and therefore the branches of the cervical nerves cannot be connected with its descending branch merely for exciting the contractile power of the muscles, but for associating them in action with other parts. Different nerves are combined for the muscles, the skin and several contiguous structures, all of which require this mutual co-operation; but after one has left the branches destined for the skin, and has entered a muscle, filaments of it may be traced to the periosteum and bone, or a joint, a plain proof that it has not entirely motive properties, but gives sensation to these parts and connects them with the muscles and skin, that in great exertions the muscles may be able to measure the degree of force necessary for the completion of their object, and have it proportionate with the strength and safety of the bones and joints and fascia to which they are attached, and that for nice operations they may move in concert, and be directed by the delicacy of the sense of touch. Many of the uses of these conjoined faculties are acquired in early life, and in a considerable degree previously to the attainment of manhood. Improvement may be made after this period, but the fundamental qualifications for effecting it have been acquired in youth. All mechanical instruction should be begun early, that the muscles and skin and nerves may by continual discipline, before settled habits have been acquired, be brought into those actions which will be conducive to the perfect mastery in the art for which each person is designed. When the muscles and nerves have been thoroughly disciplined, many of the operations are performed with a very slight attention of the mind. If after this period any considerable progress or improvement is to be achieved, it must be done by mental attention, but even then, unless there has been a sufficient preliminary training, it is difficult to bring the nerves and muscles under such control as will effect the desired end. If a person has been accustomed to do what requires the forcible use of an instrument, he will usually find the gentlest movements with a very light one heavily, if not roughly executed; on the contrary, a person used to a very light instrument on soft substances, will not act with sufficient firmness for insuring a sufficient impression on the hardest. It would seem as if the nervous centres did not favour, and the nerves and muscles did not allow of, much mechanical improvement after a certain time.

The nerves originate in a defined order, and it is probable that this arrangement takes place, not merely on account of the convenience of supplying the organs which are most contiguous, but because the several parts of the brain are best calculated for producing the necessary qualities of the nerves, and connecting these more or less extensively with the particular tracks which enlarge their powers according to the exigencies of each animal. The olfactory and optic nerves, which appreciate the most subtle agents, arise directly from the anterior part of the brain, but those of hearing, tasting, and feeling, which are generally excited through more powerful means, arise posteriorly and in a different manner; the rest, if those of the muscles of the eye be excepted, have modifications of perception, and other peculiarities, which interest the vitality of the whole body. However important the olfactory and optic nerves are, abstractedly considered, their absence would not interfere with the general functions of the body, provided there is a proper supply of nourishment and exercise; the nerves of the muscles of the eye have a limited distribution and power; the fifth, seventh, and ninth, have also a local influence, but more extensive than the preceding; whilst the par vagum is very little affected by the nerves anterior to the fifth, but it is very much connected with the functions of all the nerves arising from the spinal marrow, through the branches of the sympathetic, which so frequently communicate with the visceral nerves. The spinal nerves arise from the spinal marrow in an order most conducive to their independent actions, but are still capable of that free connexion with the brain which is required in parts so extensive, and whose functions are so subservient to the commands of the intellect. The perceptive power of each nerve also varies according to the structure and mode of its termination. In invertebrated animals, fishes, and amphibia, there is a smaller proportion of the medullary matter to the cellular; this change may diminish the acuteness of the perceptions of the nervous system, but make it more retentive of life, and therefore less susceptible of any interruption of its functions from a want of depuration of the fluids, so incessantly demanded in the higher classes. Although the origin of a nerve be extensive, its perceptions may be less vivid in degree according to the diminutive size of the hemispheres of the brain, as well as the smaller proportion of medullary matter to the neurilema.

For receiving and conveying particular impressions, the nerves must generally be attached to peculiar centres, and partake of their qualities; they must also have an appropriate structure, and be accommodated to organs especially constituted for receiving them. Some nerves have a great similarity of structure, but one can be substituted for another, only in a very few instances, as each has its specific structure and function; and although an organ supplied by a common nerve can discern light, as in the diminutive eye of some of the lower animals, yet the sense is almost entirely different. A branch from the trunk of the par vagum is not unfrequently substituted for the descending branch of the ninth; and different combinations in some animals are allied to this modification. But even the nerves of the senses in the higher classes vary in their texture, and probably in the exquisiteness of their perceptions, as in the large soft olfactory nerve of mammalia compared with the coarse and fibrous one of amphibia. There is a difference both in the appearance and structure of several nerves, but when there is no appreciable change, there may be a variation in their functions. Substances irritating the mouth and fauces, which are principally furnished by the fifth and glosso-pharyngeal nerves, may not be felt by the stomach ; and on the contrary, poison in passing to this viscus may hardly have affected the mouth, so that many of the nerves have peculiar perceptions, which can only be known by experiment. In the pelican, however, and some other birds in which organs are very much changed for a particular purpose, as well as in the snake, nerves supposed to have dissimilar functions become incorporated with each other in a much greater degree than in mammalia, as the glosso-pharyngeal, the par vagum, and ninth, besides their forming intimate communications with others, as the hard portion and several spinal nerves.

The appropriation of different faculties to the nerves has arisen in a considerable degree from the observation that particular ones belonged to organs whose properties consisted in the evolution of the senses, whilst several belonged almost if not altogether exclusively to muscles. Nerves have been divided into sensitive and motive, or compound when both of these faculties are conjoined. It is probable that there is a peculiarity of the portions of brain with which the sensitive and motive nerves are connected. There is also some difference in the appearance of the nerves themselves. The fibrils of a nerve having the greatest motive power are generally more slender than those presumed to have only a sensitive one, except of such as belong to the special senses. In the head of a calf recently killed, the hard portion of the seventh and the ninth had a close and blue appearance, whilst the rest were perfectly white ; but on comparing the nerves of different animals, an appreciable change of structure does not always correspond with the particular function. Some distinction may be made between the nerves of the two faculties, but it is difficult to define the various shades of each. It may be presumed that there is some motive power connected with the structure of the nerve independently of the centres, as after death on irritating it muscular contraction will be excited. The nerves do not appear to have the same powers when they are detached from the centres giving origin to them: some however is inherent in them, and like the irritable property of the sensitive plant, determine contractions of the cutaneous muscle or bladder, either through the application of any stimulus or even of cold to the skin.

Although nerves have particular faculties, it is possible to limit them too narrowly. Nerves have perceptibility and the power of exciting contractibility, both have some participation of the same quality; one is destined principally for parts formed for perfecting the perceptive faculty in the most exquisite manner, but several degrees of this are to be observed according to the structure of almost every organ, and the form and size of the terminating nerve; therefore when other structures receive a sentient nerve, which were not intended for conveying a positive sensation to the mind in the healthy state of the body, it may perform similar but modified functions, and still be a nerve of the same quality, but only changed either by its diminutive size, or by the peculiarity of its receptacles. So with the motive nerves; one is implanted in a muscle, which has in itself a contractile power, but the motive nerve inserted into other structures, not so formed or so capable of contraction, may nevertheless excite these to action according to its peculiar faculty and their own capability.

The sensitive and motive nerves have various degrees of perception and action suitable for organs possessing different properties. The sensitive confers a degree of sensibility on each part necessary for its particular functions and its harmonious co-operation with other organs; this constitutes ease and health. It is not improbable that the motive may impart a greater degree of contractibility and tone for resistance and resilience, for the propulsion of the contents of vessels and ducts; for the tone of the skin and the adipose and cellular membranes, as well as for the muscles, as there is a softness and flaccidity of all these parts in paralysis and other diseases; both however may be conjoined for these purposes. The paps may become erected in this manner previously to their being sucked. It is difficult to determine where muscular action ends, and this vital contractibility belonging to several portions of the integuments begins. The motive powers of the fifth, the glosso-pharyngeal, the par vagum, and others, remain active through a protracted illness, although those of the other nerves have become nearly exhausted; this difference may be in some measure attributed to their origin from the brain, the supply of blood, and the more constant action in which the parts furnished by them have been continued; some peculiarities may also depend upon the organs receiving them, and on the connexions with the sympathetic nerve.

The spinal nerves, after supplying the muscles and the structures subservient to these, terminate almost entirely on the skin, except when the mammæ and cutaneous muscle are present. The proportion of sensitive to motive nerves varies in different animals, according to that of the passive parts compared with the active muscles. In the skate, the sensitive nerves are equal to the motive, because there is so great a quantity of cartilage with joints and investing membranes as well as the integuments; in the dorsal portion of the spine of the turtle, they are proportioned to the extent of the shell, and are therefore larger than the motive; whilst in the cervical region, owing to the preponderance of muscle, they are the reverse. The nerves of each kind are united for producing sympathy and co-operation between the skin and bone and muscles, for perfecting the motions of the limbs in exercise; so that for the mere contraction of a muscle by a command of the will, the motive nerve is equal to the completion of its functions, as in the third, fourth, and sixth nerves.

There is a great difference in the several parts receiving the spinal nerves in very numerous animals of each class, as in the composition and form of the muscles and joints and bones, and particularly in the integuments. It is however probable that each of these requires a similar supply of nerves; only in a less quantity, according to their magnitude. Whether the muscles be of a deep or pale crimson, colourless or transparent, whether the bones be harder or softer, and the integuments delicate and pliant, or hard, coriaceous, and approaching to the osseous character, similar nerves are provided, and a similar distribution of them is made. When the structure of the skin is varied, it is probable that the muscles preserve some resemblance of quality; otherwise there would not be an harmonious action between those parts, which are supplied by the same nerves; so that animals having a very hard skin would have the muscles cramped; the structure may be very different, as in the soft muscle of the turtle compared with its hard integument, and both may be so nicely contrived as to prevent any undue action of one on the other; but there may nevertheless be a modified degree of perceptibility in both, as well as in the nerves.

Perception is a quality universally experienced throughout the animal kingdom, and in various degrees throughout the vegetable, but its quality varies not only in many nerves, but in the same of very numerous animals. It is limited according to the extent of the nerve and the quality of the surface receiving it, but its principal source of exaltation depends upon the extent of the convolutions of the brain; it may be powerful in a smaller brain, but the appreciation of it is different according to the extent of the intellectual faculties; therefore the greater these are, the less some of the nerves of the senses are required to be, otherwise the animal would be too much affected through its influence. All animals have a due share of it for their preservation, and allowing such enjoyment as their low condition admits; but the higher the animals, and the more it advances, the greater are the desires and disquietudes of the individuals, and the less their capability of restraint in a limited sphere. The perceptive power varies according to the origin, structure, and mode of termination of a nerve, and according to the structure of the organ receiving it, so that each part supplied will give a varied sensation. The olfactory nerve requires a peculiar state of the nose for the perception of particular odours, the optic nerve of the eye for determining objects, the auditory of the ear for appreciating various sounds, the fifth of the tongue and palate for determining the sapid properties of different substances; the sensitive nerves of the form of the papillæ of the skin for rendering them more or less perfect judges of tangible objects. Scents are attracted by the mucus according to the form of the nose, and the act of inspiration; the blood-vessels impart activity, and make the membrane more or less turgid for expanding the terminal filaments, but it is difficult to determine whether any change takes place in these independently of the organs during the act of perception. Although the whole olfactory nerve may be formed into a ganglion, and the optic and auditory appear uniform, particular classes of odours, lights, or sounds, may be conveyed by separate portions of the nerve to one part of the origin in the brain rather than another. An organ may have nerves of different degrees of sensitiveness for a particular purpose. The branches of the olfactory and fifth are spread on the same membrane, and each of these has a difference of perceptions derived from its origins, as well as some modification from its termination. The third trunk of the fifth supplies the external ear anteriorly, and branches of the cervical nerves posteriorly; the anterior surface thus corresponds with that of the temple and face, and the posterior with that of the back of the head, so that in conversation the posterior may not be so easily impressed, and the attention not so much taken off, as if the two surfaces had possessed the same sensitiveness. Some branches of the hard portion are joined by branches of the fifth, and others by cervical nerves for associating the structures with the particular functions of each region.

Although the skin is supplied by the same nerves, yet different parts of it may have its sensations altered, according to the degree of warmth or cold and exercise to which the body is subjected. The sensations of the nerves are altered by a variety of circumstances, by the state of the internal organs, or the circulation, and the dry or perspirable condition of the skin itself.

The form of an extremity, or of the papillæ of the skin, produces different effects in many animals even with the same nerves, and thus proves that the nerves alone cannot complete any particular functions. The sense of touch in man is confined to its perception of the nature of various substances, and has powers implanted by the nerves corresponding with the structure of the organ receiving them. The feet of animals are ill calculated for becoming the organs of touch, although their nerves are similar in their arrangement to those in man, and vary principally in their size and number of branches according to the toes. In the same manner all the other senses are more or less exquisite, according to the nicety and extent of the organs, as well as the size and peculiarity of the nerves. When an object is touched and seen by the eye, its mechanical relations to each of these organs become associated in the brain, so that afterwards either of them can separately, in a great measure, appreciate its form or general appearances. There are agents of which the skin may take a very erroneous or imperfect cognizance, and particularly as to the quantity of heat or cold: heat may produce an expansion, and cold a contraction of the papillæ, and both beyond a certain point an inordinate and painful contraction. Substances become impalpable in some parts, but if finer particles could have been perceived, the necessary texture of the nerves and papillæ would have been totally unfitted for their present requisite and convenient purposes.

After a division of the spinal marrow, all sensation and voluntary motion excited through the nerves arising below the division cease, or when a nerve only is divided, the same impediments to the usual functions of a nerve are produced. Therefore a decided communication exists between each portion of the spinal marrow and the brain, and between the latter and each nerve. An inherent power is presumed to exist in the nerves themselves; as in the higher classes, they are not only larger for more exalted functions, and smaller for more obscure ones, and larger in proportion to the size of the animal and not to that of the brain, but vary in the disposition of the fibrils according to their required uses. The extensive plexuses of the hard portion of the seventh, which are distributed over the face and attached to so small a trunk, favour this conclusion.

The nervous system has a general character, and although it is modified for particular functions, sufficient similarity is preserved for forming a harmonious whole. Nerves are usually larger or smaller and of a different structure according to the faculty depending upon them, and are modified by the quality and mode of connexion with the centres. Both the centres and nerves are growing at the same time during the evolution of the fœtus; and as each nerve has similar qualities with the portion of the brain to which it is joined, its origin, course, and termination, must be considered as the continuation of one and the same part, and incapable of separation, unless in portions of its entire length. It is difficult to say whether the brain at the origin, or the nerve and the organ receiving it, are of the most importance, for one part cannot be injured or removed without impairing the functions of the whole, except in some of the lower animals.

As ganglia and nerves are larger than the nerves entering them, and have more ganglia appended to them without any increase of the other centres; and as nervous matter is generated at the same time with the several tissues of each organ, more may during the evolution of the fœtus be combined in one organ rather than another, and be nevertheless connected with the other parts of the nervous system through the nerves just as much as will answer their required purposes. It is by no means certain that distinct centres are necessary for the maintenance of vital actions, but if an animal is to be directed by a will, and this is to be reacted upon, so that there shall be a connected series of faculties, a centre is necessary; if, however, it is to be depending entirely on external circumstances, and the changes taking place in its several parts are to be the result of these, it is not improbable that a smaller proportion of nervous matter generated amongst the other tissues may suffice. Nervous matter is modified to each organ through the neurilema, and may therefore be at once combined with the muscular fibre, if this approach near enough to the qualities of the neurilema.

In morbid conditions of the nervous system, especially after paralysis or a mutilation, a nerve of sensation or the skin receiving it sometimes more readily than in health, conveys a stimulus to a muscular nerve, and produces a contraction of a muscle, although the will cannot. This is the reflex power mentioned by Willis, and other physiologists. There is, therefore, either perceptibility as a quality of the mind, and perfected through the brain; or an indescribable one not appreciated by the mind, but approaching to that of the viscera, the blood-vessels, and other parts. This communicating faculty may reside in the centre, giving origin to the nerve, and be either in the brain, the spinal marrow, or a ganglion of the sympathetic nerve.

There are peculiarities in all the organs of different animals, as well as in the nerves distributed to them, but particularly in the vital properties of the muscular fibre. In the muscles of the skate, the eel, and others, the intestines and the heart generally, but especially in the young, a great degree of irritability is present a long time after sensation and volition have ceased. In the skate the auricle is very retentive of the contractile power, which will continue for several hours after it has been cut in pieces, notwithstanding it is so thin as to be almost transparent. This irritability exists independently in a greater or less degree in all muscles, but for producing voluntary action as well as a co-operation with other organs, their connexion with determinate portions of the nervous system is generally necessary. The viscera may contract spontaneously when empty, they may also be influenced through the nervous centres, and the quantity of their contents producing distension, or the quality of these irritating the terminal filaments of the nerves on their lining membranes. It may be a question whether the irritability be entirely a quality of the muscular fibre, or it has been produced by a greater proportion of nervous matter than exists in other structures, and which has been modified with it in the same manner as nerves are in ganglia. It is hardly probable that the voluntary muscles contain a greater quantity of nervous matter than the nerves entering them, as the will could not then entirely control them, but they would be perpetually liable to an undue excitement, as in tetanus.

The voluntary muscles are supplied by the spinal and some of the cerebral nerves, the involuntary principally by the sympathetic. There are involuntary actions of muscles supplied by the same nerves as the voluntary, but excited by particular causes, as the motion of the blood-vessels on branches of the sympathetic communicating with voluntary nerves; by the action of moving parts directly on voluntary nerves, or by some medicines, tetanus, or an extraneous body, irritating them. There is also a particular state produced by the great plexus between the hypogastric and sacral nerves, which has both voluntary and involuntary powers. Some of the involuntary muscles are formed originally for their particular state, and would not execute their requisite functions so well if they were actuated by voluntary nerves, unless these had undergone some previous change. The parts to which the involuntary muscles belong, require a propelling power suitable for the accomplishment of their functions, and over which the will cannot properly act, because it is necessary for it rather to suit the feelings of the lining membrane of the organ, than the sensibility depending upon or connected with the brain. The intestinal canal perceives the nature of the aliment, and determines the time and state in which it is to be propelled, the different planes of muscular fibres acting either according to the perception or the degree of distension; the sensorium does not perceive it until the feculent remains are to be excluded, and then the intestine has, from a supply of common sentient nerves, become perceptive of its quality, and the will has the power of effecting its expulsion. The heart perceives the influx of the blood and circulates it; the influence of the will would make its actions irregular, varying with every mental impulse, and not sufficiently dependent upon and sympathising with the viscera, which elaborate the blood, and therefore would not circulate it so well according to the demands of the system. These parts are, therefore, generally supplied in a great degree by the sympathetic nerve, the perceptiveness of which is sufficient for allowing the lining membrane to appreciate the nature and quantity of the contents, and continue the perception to the muscular parietes for exciting or depressing their action according to the necessity. In some animals a different degree of perceptiveness is required, and therefore the nerves as well as the organs vary, and some of the involuntary muscles, as the diaphragm, are supplied by the common voluntary nerves, and these are excited to action partly by the stimulus from the pulsations of the heart. A muscle is excited to action through the centres, by the will, or any extraordinary stimulus of the parts of the centres connected with the origins of its nerves; by irritation or a common perception of the skin, or of the lining membrane of the viscera, by extension or other exciting agent either of its fibres or of the nerves supplying it, and through communicating branches of other nerves.

Although a great similarity exists between the nerves and muscles, there are still peculiarities in different animals. The greater or less rapidity of action of the muscles and their inherent vitality may in some measure be connected with the original quality of the muscular fibre, and the nerves of the oblong and spinal medulla, or some portion of the centres, the continuance of motion and its complexity upon the hemispheres of the brain and cerebellum. If animals can outstrip man in swiftness, he can make a more protracted exertion without rest; it may, however, be questioned whether a superior nervous power is derived from the large hemispheres, which pervading the system allows an endurance of action, or whether the intellectual faculties through the hemispheres enable him to make resolute and well-timed exertions, and sustain them by appropriate food. In mammalia and birds, the energies are greater, and can be much longer preserved than in amphibia, which have a smaller brain and less perfect and distinct circulating and respiratory organs and functions. In mammalia and birds, the well-being depends upon a more continual action of the heart and lungs co-operating with each other; it is probable therefore that whilst the brain and nerves derive a pabulum from the blood, purified by oxygen and the elimination of noxious matters by the liver and kidneys, the muscles partake of the same influence, from which they acquire a portion of their power.

The nervous element, or the essential part of the nervous system of every animal, can only be combined with living matter. It begins at conception. In a perfect egg it becomes capable of being excited by heat during incubation, and then of promoting the development of the fœtus. It may appear to be almost annihilated in the torpid season of some animals, and be restored again to its most active state. It may be entirely lost by a sudden shock. It may remain for a longer or shorter period after apparent death, when the circulation, breathing, and consciousness have ceased to exist, and then be made manifest by stimulants. It is different from every other natural agent yet discovered. Its influence or agency has been compared with that of electricity, because very large nerves supply the electrical organs of the torpedo; because, after a division of the par vagum, digestion has been promoted by galvanism; and because galvanism separates different substances from their combinations, and thus resembles the nervous element in promoting the secretion of various fluids from the blood. On the contrary, the imperfect transmission of the nervous element, after a nerve has been included in a ligature that would not retard the progress of electricity, or by communicating nerves, leads to the conclusion that the nerves do not convey anything similar to the electric fluid. The nervous element may be modified by its combination with the different structures of the brain, the ganglia, and nerves, and the functions of each of these with the respective organs for whose particular use they were designed; but it has not been proved that it can be changed by any part of an animal body, and especially the electrical organs of the torpedo, so as to become free electricity. If electricity be made apparent, there is no proof of its proceeding from the nerves. Although the nervous element may in some of its effects appear similar to electricity, yet without further discovery the comparison cannot be maintained; it must therefore at present be considered as a peculiar power.

The influence of the nervous element, or, as it is sometimes called, the nervous energy, pervades every structure of the body receiving nerves, and in its ordinary and most efficient state proceeds from a healthy condition of the nervous centres, which, as well as the nerves and the organs receiving them, must be supplied with blood, from time to time replenished by food, and submitted in a greater or less degree, according to the nature of the animal, to the influence of oxygen. Although a simple nerve has sufficient power for the necessities of the lowest animals, yet in the highest, even when it is well supplied with blood, it has not for the perfect functions of the organ in which it terminates; the oblong medulla, or even the ganglia of the sympathetic, probably furnish the nervous element in the same proportion with the centres of the lower classes; but for its full influence a large and perfect brain is necessary. If the nerves be separated from the brain, or the spinal marrow be compressed, and a considerable portion be left perfect, as the centre of many nerves, the structures receiving these waste, and have their functions languidly performed. Parts may become devoid of sensibility after their communication with the brain has been cut off; but there is a deficiency also of that power derived from the brain, on which the feeling of strength along with that of pain depends. It is not improbable that the nervous element is imparted to the circulating blood. It keeps every part of the body in tone, or that agreeable condition which tends rather to exalt the animal or mental functions and feelings, but it does not produce any very sensible excitement; it is a state of ease, but at the same time one of ennui to man, for compelling him to seek employment; and of satisfaction to animals generally, by inclining some to get fat for his support, and others to husband their strength until he requires their exertion.

As there is not anything in the nervous element which can make it apparent to the senses, its presence may be considered as conjectural. Its existence is, however, most fully proved by the manifestation of its power in the various processes in which it takes a part in the living body—by its exaltation through stimulants, and its depression or destruction through poisons. It produces evidences of its power in the various results from its action on different organs, which would not have taken place without it. If tubes were constructed so as to resemble the distribution of the nerves, and these were to be supplied with an inflammable gas, which might escape at various perforations, this, on being lighted, would produce a flame of the shape of the body, and, by its fresh combinations, convey light and heat to the surrounding air. Before the flame came in contact with the gas, nothing was visible; its existence, therefore, as far as one sense is concerned, might have been denied: but such positive evidence to the sight has not yet been adduced with respect to the nervous element; to reason, however, its presence and power are not less clear.

Besides the nervous element, the instinct of animals has also been previously noticed. This exists as an element or essence. In the higher classes its residence is principally in the brain, but different degrees of its power belong to particular portions of this organ; its influence is also extended from this to other parts of the nervous system, for there is not only the mental memory, but a feeling of the previous integral state after the amputation of a limb. In the lowest classes it may exist in ganglia, or even in a nerve. It is powerful, and acts in proportion and manner, according to its extent and quality, through the nervous system; some parts of the centres and nerves are therefore larger and more complex in one direction than in another, in the same measure as organs are required to be actuated by it. It excites muscular motion, and receives sensations from without. It limits the extent of the growth of the body generally, whilst that of some parts is determined also by external circumstances; it directs the reparation of injuries. It is a glimmering of the divine irradiation for giving subtlety and the power of contrivance for predetermined purposes; but in its highest degree it does not approach, and cannot be maintained as bearing any comparison with, the capacious intellect of man. Although it affords the measure of intelligence for directing the energies of the animal through the nervous system and appropriate organs, it permits only a moderate degree of action in them without its being either disturbed or having its union with the body dissolved.

The instinctive essence is usually denominated by the will, and by the seat of sensation, the sensorium. The will is the more active internal stimulus which excites the regular contraction of voluntary muscles. The sensorium is a more passive faculty, which allows the nerves and parts of the brain communicating with it to be excited by external agents, as air, heat, food, and other things. The sympathetic nerve is not under the immediate control either of the will or the sensorium, yet it partakes of some of the qualities of the instinctive essence: it supplies involuntary muscles; it also supplies the lining membrane of the viscera, which requires a peculiarity of perception, for permitting the continual circulation of the blood, and the digestion and assimilation of food. In the higher classes, and particularly in man, the more acute quality of the sensorium would occupy too much of the attention and impair the independence of the mental faculties, even if it would allow the reception of the necessary varieties of food, therefore it has been modified by the construction of the sympathetic nerve.

However difficult the comprehension of the nature or even of the presence of spiritual agents may be, their existence, efficiency, and power, must nevertheless be admitted. The physiologist must go beyond tangible and visible objects if the functions of the nervous system are to be understood.

For convenience, the functions of the nervous system have been divided into those which are principally innate and modified by the arrangements of the centres and nerves, and into others particularly depending upon the influence of various parts not belonging to the nervous system, but concerned in the production of its excitement, and without which the full development of its powers cannot take place; and amongst these are the muscles, the heart and blood-vessels, the blood, air, food, and exercise.

The first dawn of life is excited into action either through some provision in the body of the parent, or some external agent, as heat applied to the egg. The excited living power produces the first evolution of organic structure, and shortly afterwards the heart becomes apparent, which soon and ever after takes a prominent part in perfecting the functions of the whole body, but most particularly in those of the nervous system; its influence is not, however, equal in all animals, as so much also depends upon the warmth and coldness of the atmosphere and other circumstances; nevertheless the heart generally, when it has been once brought into action, continues so until death; and although life may persist without its influence a longer time in some instances, yet in others it is very speedily extinguished. It therefore appears that the essential part of the nervous system may lie dormant in the egg, also in the more mature bodies of some animals, but that generally, when it has been once excited, it requires a perpetual stimulus for keeping it in connexion with the body. Even when combined with the various structures of the nervous system, it is incapable of producing any decided effects without the co-operation of several agents.

The functions of the nervous system are promoted by their contiguity to moving parts. In man particularly, the lower portion of the œsophagus is surrounded by branches of the par vagum; the two trunks are thus differently combined, but it is probable that the nerves are at the same time made capable of being excited by the passage of the food along this canal, preparatory to their active functions in the stomach. In invertebrated animals the œsophagus is generally surrounded by the beginning of the nervous system, which in the leech during the act of sucking is agitated and stimulated, the full stomach also distends and excites the contiguous nerves. The large artery passing between the divisions of the nervous chord as in the lobster, and through the ring as in the crab, have a similar influence.

The functions of the nervous system in the higher classes of animals are promoted in a considerable degree by the activity of the sanguineous system. The pulsations of the brain are to be attributed to the action of the arteries, and not to respiration, as they are synchronous with those of the heart; their number is greater in a given period than that of expiration, during which it has been supposed they were produced by the delay of blood in the right cavities of the heart, and consequently by a distension of the jugular veins, as well as the sinuses and veins of the brain. A difference in the number of pulsations of the brain is observed as the effect of irritation; it is, however, doubtful whether they exist merely as a natural consequence of the formation of the brain consistently with its supply of arterial blood, or whether they minister in a decided manner to its functions. The rete mirabile shows that a modification of the supply is necessary in different animals, a forcible current is, however, continued through this structure, for on dividing the carotid arteries in the calf, the blood sent by the vertebral returns pulsating through the upper divided ends. Whether the arteries reach the brain from the carotid by continuous branches, or through the rete mirabile, they are ramified in the pia mater and the cellular tissue containing the cineritious and medullary matter. A greater proportion circulates in the cineritious matter; but some vessels containing red blood are found in the medullary; it is, however, probable that this admits principally the colourless parts. The spinal marrow appears to require a similar circulation. The blood-vessels of the nerves ramify on the neurilema, and throughout their course are moderately supplied with blood from neighbouring branches, but receive more during their excitement, and it is most probable that they are generally sustained by the colourless parts. Particular arrangements of the vessels are necessary for completing the functions of some nerves, as in the cavernous form of the veins of the nose, the choroid coat of the eye, and in others in various parts of the body. Injected structures show the course and disposition of the vessels, but are not to be considered as bearing much analogy to their state in the quiet and healthy condition of the circulation.

Ganglia are supplied with blood by neighbouring arteries; in their healthy state they do not require much, but are supported chiefly by the colourless parts; it is probable that, when they are excited, numerous vessels containing red globules become apparent, during their active healthy functions, in inflammatory diseases, and after the use of particular medicines. On a minute injection after death, the ganglia are very vascular, but this is not their ordinary appearance. Ganglia have an innate power which is modified by their blood-vessels, and increased or depressed by various agents; but the principal functions of the nerves issuing from them are promoted by the quantity and mode of intermixture of the arteries with the terminal filaments near to or in the organs receiving them.

Plexuses require particular arrangements of the vessels connected with them. Although the larger vessels of plexuses in some measure promote the functions of the nerves, it is at or near their terminations in which they exercise their greatest energies, otherwise every part supplied by a large plexus would be brought into the same action; so that not only are the nerves of each organ, according to its required use, properly stimulated, but the action is not in an inordinate manner communicated to other organs. Although the whole of a plexus is excited at once by a general stimulus, as by wine taken into the stomach, yet the peculiar functions of each division of it depend upon the state of the organs it is destined for at the time, so that if there be food in the alimentary canal, assimilation is promoted, and in the same way the secretion of the liver, or that of any other part. Numerous small vessels may be seen amongst the plexuses of nerves in the abdomen and behind the pleura, when any excitement has prevailed there ; but these are in a very moderate quantity under ordinary circumstances, and in all probability they convey only the colourless parts of the blood.

Many of the blood-vessels are furnished by the sympathetic nerve, and are thus more particularly connected with the heart; others receive filaments from neighbouring branches, and so have their actions more readily associated with the different parts through which they pass. The nerves enter into the texture of the coats of the arteries, probably also into that of the minute branches ; and the cellular tissue, forming the ultimate expansion of many nerves, becomes incorporated with the cellular tissue generally, and the capillaries and absorbents, and assists the functions of these, as the branches of the par vagum do those of the parietes of the air-cells, which receive the extreme branches of the pulmonary artery and the beginnings of the pulmonary veins, and give off at the same time exhalations in some respects similar to those of the common cellular tissue of the body.

A stimulus may be communicated directly to an artery through a nerve, and a nerve may be mechanically excited if placed in contact with the artery. The power of a nerve will be elicited according to the stimulus, the effect of which may be fugitive or permanent, and producing a state bordering on inflammation. When a stimulus continues, as in a portion of diseased bone, the neighbouring nerves and blood-vessels are excited, and then other parts are implicated, and through these more or less of the body. The extension of this irritation, however, depends most upon the nerves, for in the case of a large ulcer on the leg, connected with a disease of the tibia and attended with great pain and a profuse hemorrhage, although the diseased bone was the stimulus, the increased arterial action was in a considerable degree produced by the implication of branches of the peroneal nerve, for, on removing a portion of this at a distance from the ulcer, not only the most violent pain ceased, but the bleeding also.

The supply of blood is regulated by the nerves during the action either of a single organ, or the whole body, for the heart itself can only circulate it generally by a uniform impulse over the system, and without this influence of the nerves, any change in the action of an organ would misdirect it, and produce confusion. The nerves and blood-vessels, by ministering to the functions of each other, preserve the balance of both, the impulse of the blood exciting the nerves, and these the contractility of the coats of the vessels, and preventing over-distension. Any moderate excitement may be confined to the nerves and blood-vessels of the part, but one more extensive is communicated generally to the nervous and sanguineous systems, as in exercise producing healthy action throughout the body, and in an inordinate exertion, irritation and fever. The minute arteries have both sentient and muscular powers, derived from their nerves, and are thus well associated with various structures. If a vein be opened and the blood does not flow, if the hand be immersed in hot water, the skin perceives the heat; the arteries do also, for the action of these becomes excited, and causes a rapid return of blood through the opened vein. Although the power and action of the blood-vessels depend in a considerable degree upon the heart, yet without the perfect functions of the nerves the blood does not circulate so freely. If after the nerves and blood-vessels have been excited the same stimulus continues, it tends to produce a more and more rapid augmentation of the enlarging organ, and this an increasing power of the nerves and arteries, so that at conception the uterus and its contents grow slowly at first, but afterwards advance every day with a greater proportionate rapidity. These observations to a certain extent will apply to morbid growths.

Many nerves, and particularly those of the viscera, accompany the arteries to their termination. This arrangement may afford a convenient support and mode of conveyance to the nerves, but it is very probable that the functions of the nerves themselves, and of several organs in particular, are promoted by it. Many branches of nerves encompass the heart and blood-vessels, by which a mechanical stimulus can be given to them. But some of the arteries are surrounded by loose cellular membrane, their pulsations therefore have not much influence on the circumjacent parts.

Some of the veins are accompanied by nerves, and particularly those underneath the skin of the extremities by the cutaneous, and in the inferior vena cava of mammalia by the right phrenic. In birds the par vagum accompanies the jugular vein instead of the carotid artery, as in mammalia. The veins are scantily supplied with nerves, but when they furnish blood for secretions, or other important purposes, they receive a more copious quantity, as when filaments from the hepatic plexuses supply the branches of the vena portæ. It is probable that all the veins are influenced by the state of the nerves, and become over-dilated, not only by any obstruction to the return of blood at the viscera, but by the want of tone, which a diminished nervous power produces; and as the pores of the skin are relaxed in some instances from the same cause, profuse perspiration may take place. It is, however, probable that several nerves accompany veins, more on account of their safety than for the performance of any specific function, and that the par vagum accompanies the jugular vein in birds, that it may have a more free position than if it had accompanied the carotid artery in the more limited receptacle upon the middle of the spine; but by adhesion to the vein it is secure from the action of the œsophagus in conveying the food, because the force of the pressure falls principally on the returning blood. When however the veins assume the place of arteries, nerves accompany them for the same purpose they do the arteries, for exciting them, and connecting them more particularly with the functions of the organ on which they are about to terminate.

The nervous system in many animals is supplied with blood which has different qualities, and is submitted in a greater or less degree to the influence of oxygen. In man the brain is larger in proportion to the heart and lungs than in mammalia; there may be some approach in a few instances, as the brain may be extensive or the heart diminutive; the size of the head, however, as compared with that of man, makes a larger supply of blood necessary, as in one there is more brain, in the other more bone and the several accompanying structures. The heart and lungs, the oblong medulla, and spinal marrow, are more proportionate in mammalia, in comparison with the same in man, than the brain and heart, and are equal with the required quantity of nerves and blood for the trunk and limbs. In birds the brain is small; the heart and lungs appear also small when compared with the size of the body, but not when an allowance is made for the lightness of the bones, and the extent of the aerial cavities; the spinal marrow is proportionate with the heart and the parts receiving its nerves. In amphibia the brain is not so large when compared with the heart as in birds, but the spinal marrow is rather larger; the blood is more imperfectly submitted to the influence of oxygen, so that the nervous system is not only altogether more extensive than the quantity of blood circulating through the arteries, but the blood is less stimulating, and the nervous system therefore less active. In fishes the proportions of the several parts approach very much those of amphibia. The blood is more slowly circulated and less liberally oxygenised than in mammalia and birds, so that the nervous system is partly on this account less easily excited. The heart is proportioned to the necessary quantity of blood, and the force of its circulation for the body generally; the blood-vessels are constructed and arranged according to the structure and required functions of every part; they have a capability of enlargement or diminution; and determine some functions of the nervous system and are directed by others.

The more exalted the structure, and the larger the nervous centres are, the more blood they require in performing both the intellectual and animal functions. The lungs provide for the necessary exposure of the blood to oxygen, and are capacious for the uses of the spinal marrow and its nerves, and the body generally, but more especially for those of the brain in mammalia and birds. The functions of the brain and spinal marrow are languid in amphibia and fishes, both on account of the slow circulation and the inferior respiration; and although mammalia and birds can exist a short time under similar circumstances, their condition is feeble and distressing.

After the birth of an animal, something deleterious to the nervous element is generated with the nourishment, and requires to be eliminated, for preserving the vital properties of the body. This is effected principally by respiration; it is also assisted by the liver and kidneys, and the absorbent system; and these organs are evolved in a greater or less degree, according to the extent and quality of the nervous system. Although the nervous system cannot continue its functions without the lungs or some compensating organs, these are not made for the nervous system only, as every part of the body requires a share of blood purified in the same manner, that there may be an harmonious action throughout.

Besides the peculiar distributions of the blood-vessels in promoting the functions of the nervous system, the blood itself takes a very important part, and in the higher classes of animals appears almost to give life to the body; nevertheless, after it has ceased to circulate, vital phenomena may for some time be present, and even its circulation, unless its state be repeatedly changed by exposure to oxygen, is not generally sufficient for the retention of life. Blood having the same inherent or acquired properties is not necessary for every animal, but such as will harmonise with the quality of the nervous system of each, and the several organs of the body.

Blood is rendered efficient according to the greater or less influence of oxygen, and any acquisition it makes from the nervous system may be presumed to proceed from the nerves during digestion and chylifaction, and from the par vagum in the air-cells of the lungs. Willis, in speaking of the living principle of the blood, says, "Although the blood be animated or partaking of vitality, yet it is hardly sensible or perceptive." Allowing for the vital power of the circulating blood, or for such as remains fluid after extravasation in an aneurism, it may be questioned whether, after its coagulation, it ever becomes organised: vessels have indeed been seen to pervade it, but they have belonged to the extensible cellular tissue into which it was effused.

Every part of the nervous system acquires a stimulus or pabulum from some essential properties of oxygenised blood for the completion of its functions, and these are more or less energetically performed according to the quality and supply; if the current to the brain be stopped for a short time, the powers of the body are diminished, and, if a little longer, these cease altogether. Poisonous things may cause death either by destroying the nervous element, or impairing its energy, for without this the functions of the lungs are not well performed for producing the salutary changes of the blood, and without the influence of the air the nervous element is very deficient or soon becomes either exhausted or inert.

Independently of the blood, there is a more enduring vitality of the solids in some animals than in others. Amphibia with a very slow circulation of blood, moderately influenced by oxygen, under peculiar circumstances can retain it much longer than birds and mammalia. The shorter the period elapsed since the fœtal state, the less liable is the body to death from a want of the changes in the blood by oxygen, in some measure because the nervous system is not so fully developed, and has lately been so accustomed to venous blood, but principally because some remains of the vicarious passages continue, and keep up a circulation, which the passive lungs would otherwise have prevented.

Although the blood has so much power over every part of the body, the functions are not well performed independently of the nervous system. After a nerve has been divided and its communication with the brain cut off, the nervous element is present in it; for although it cannot convey either an impulse to the brain, or through this the influence of the will, it can on its being irritated perceive, and then excite the contraction of a muscle, thus showing that it preserves its inherent faculty. The blood also continues to circulate, not however so freely as when the communication with the brain is perfect, for in the part supplied by this nerve there is an enfeebled condition from the want of that general, active, and sustaining power, on which the full vigour of the body depends.

The more sound and healthy all the organs of the body are, and the greater the equality of the circulation, the more easily the balance between the vascular and nervous systems is interrupted by the abstraction of blood. The powers of the nervous system are weakened by a too sudden diminution of this fluid, and its general functions are more or less disturbed according to the constitution; it may with less inconvenience be gradually accommodated to a smaller supply. The loss in health cannot be compared with the same in disease, as the recently inflamed organ, the irritated sympathetic nerve, and more or less disorder of other parts, have occasioned some of the distressing symptoms. In a healthy body proper food alone may obviate the effects of the loss of blood; in a diseased one, however, much caution is necessary against over-exciting the remaining powers, and reproducing the inflammation, and against stifling them in attempts to tranquillise the nervous system, and thus rendering the lungs incapable of effecting the changes in the circulating blood necessary for the support of life. In animals many circumstances are different, and particularly in the absence of the mind.

Some of the variations in the functions of the nervous system of different animals are to be attributed to the size of the brain, the proportion of the medullary matter to the neurilema, and to the quality and disposition of each of these, others to the blood or the vessels circulating it; many of these modifications exist for accommodating each animal to its destined habits, situation, and food; to the same law are to be ascribed the variations of morbid actions, and of the effects of medicines. But through the influence of the mind, its discipline and embarrassments, so peculiar is the constitution of each individual of the human species, that the slightest causes may produce an undue excitement of an organ, or some portion of the nervous system; differences may occur in animals from a peculiarity of structure and other circumstances, but not to the same extent.

The properties of corresponding parts vary, therefore a particular poison, medicine, or disease, does not affect all animals, nor the same equally at every period of life. Whatever is cognizable must be used in a limited degree to be agreeable, for if it be of a very prejudicial kind, or if innocent, it be too long continued, changes take place in the organ or its nerves, which must be considered morbid.

The nervous system may be primarily affected by things which act immediately upon it, or secondarily from its combination with the blood-vessels, as in the communication of irritation from a local cause. The exciting passions through the brain and stimuli through the nerves may at once produce an inordinate exaltation of the nervous element, and an arterial activity of the circulation, which is generally proportionate with the cause; but the excitable and exciting powers of the nervous system soon become exhausted, arterial action therefore diminishes, and venous congestion in the same proportion takes place. The depressing passions, long-continued exertions, poison, and an unwholesome diet, through the brain and nerves, may at once stifle the nervous element, or diminish its power over the circulation, and favour venous congestion by impeding the return of blood, because the impaired functions of the air-cells of the lungs, on account of the want of the same stimulus, do not allow the blood to be transmitted properly from the extreme branches of the pulmonary artery to those of the veins, and be sufficiently subjected to the influence of the air, thus producing effects in a considerable degree resembling those arising from a division of the par vagum. Each of these states may be attended with uneasy sensations or pain, the one from oppression of the organs by oxygenised blood, the other by venous. The former state may be reduced permanently, the latter only temporarily, by depletion, as this increases the tendency to congestion, because it diminishes still further the nervous energy; but stimuli by supplying this deficiency of power lessen the congestion, because they restore due action to the organ, and allow the arterial blood to be propelled sufficiently through it for giving some impetus to that in the veins, or to be disposed of through its renovated secernent functions, whilst depletion impairs the condition, which is already too low, and still further delays the current of blood. The distinction between the two states may be difficult, but it must nevertheless be made for the safe treatment of diseases.

It is probable that the excited action of the nervous and vascular systems belongs more particularly to the two higher classes of animals, and that with venous congestion to amphibia, in which the vital power is so soon diminished, or even extinguished by some depressing agents, as cold; notwithstanding, from a peculiar composition and construction of the nervous system and the various organs, particular animals of this class under certain circumstances can retain life in a remarkable degree.

The power of the nerves in promoting the functions of secreting organs has been already noticed: a few further observations remain to be made on this, as well as on the connexion of the nerves with the absorbents. Secretion is related most to the arterial circulation, and is assisted by the propelling power of the heart; it therefore in many instances is promoted by the nerves passing along and in contact with the arteries. An exception, however, is to be made when the veins convey the blood to an organ for the secretion, as in the liver. Absorption is more related to the venous circulation, and is influenced in a considerable degree by the state of the right auricle immediately after the blood has been sent by the right ventricle to the lungs. Secretion appears to be under a more powerful influence of the nervous system than absorption. Violence may impede the secreting power, not from injury done to the brain only, but from a shock given to the nervous system generally; for if the spinal marrow be compressed, and the communication with the brain suspended, it is not arrested in the parts supplied by the nerves arising below the injury.

The most numerous absorbent glands, as in the fauces, neck, thorax, abdomen, axillæ, and groins, are placed so that they can receive filaments directly from the par vagum or sympathetic nerve. Filaments may also be sent along the absorbent and blood-vessels. The absorbent vessels may not require to be exclusively supplied by the sympathetic, but like the arteries and veins in each region, by partaking of the circumjacent nerves, may become associated more freely with parts amongst which they are acting, and thus have their functions modified. The sympathetic gives branches to the blood-vessels and the contiguous cellular and serous membranes. As the absorbents begin in the cellular membrane, to which the terminations of the nerves become so very similar, it is difficult to discover the boundaries of each. The remarkable number of nerves throughout the thorax and abdomen, which are placed amidst the absorbent glands and vessels, appears to be intended in some measure for promoting the functions of these; but as absorption can begin from the skin, and the vessels become susceptible of irritation set up in this part, it is probable that some of the absorbent vessels receive cutaneous nerves.

The nerves may have irritation or even inflammation communicated to them from the surrounding absorbent vessels and glands, or be encumbered by enlargements of these, and produce different symptoms according to the locality of the affected part, so that whilst acute pain may accompany the disease, which has implicated the more sentient cerebral and spinal nerves, a different kind of pain or mere depression may arise when it extends to branches of the par vagum and sympathetic; therefore there may be greater constitutional disturbance in the most sentient parts, but not more danger, as in the implication of the sympathetic and par vagum the progress of morbid action is more insidious, and in being less marked by pain, acquires a degree of mastery not very readily subdued.

The absorbent system suffers from depressing agents, as cold, the insufficiency and badness of the food, and from a derangement of the health arising from varied causes, on account of its supply of nerves, which are very minute, and tributary from contiguous ones, whose functions are always varying with those of the structures receiving them. If any part of the body be debilitated, the nerves of the minute arteries, veins, and absorbents, share in the depression.

The powers of the nervous system cannot subsist without blood, neither can they in the higher classes unless this, after longer or shorter intervals, has been replenished by food, except in some particular instances, as in animals which lie in a state of torpidity. An individual does not demand the same nourishment in every climate, nor at every season; changes from an impure to a pure atmosphere, or from cold to heat, produce a general excitement, which is discerned by the appearance as well as the pleasing sensations throughout the body, and make a considerable difference both in the required quantity and quality of the supply. The food must be of a particular kind for harmonising with the quality both of the blood and nervous system, for if it be not, the nervous influence is not properly imparted for its digestion. The sorts of food which are congenial to each animal cannot be changed altogether with impunity, nor indeed in many instances in a very material degree. Carnivorous animals must generally have flesh, but this may be varied; the herbivorous and graminivorous must have herbs and grain; some may have both flesh and grain; man may have almost everything after a sufficient preparation, except the most rank and poisonous substances. It is contrary to both reason and experience to apportion any particular sort for the nourishment of every person, for however wholesome it may be, it becomes loathed; some essential part of it may be so gradually imbibed by the fluids as to be borne a considerable time without producing any decided influence on the solids; but at length perceptible changes are accomplished, and the nervous system, on having become either too much excited or depressed by its continuance, is generally disinclined for its further use, and not the nerves of the stomach only. As the body varies in every season, a change of diet becomes necessary, and is eagerly sought after. Man has the power of varying his food, and so have animals to a certain extent in a state of nature, for although some are always carnivorous, yet the flesh on which they feed has been modified by the succession of different herbs and fruits.

As the flesh of many animals partakes of the nature of their food, and with it the nerves, it may be worth while to inquire into the physical states of the nervous system of different individuals of the human species in various situations, where particular sorts of food are consumed, and to note their feelings and diseases; and attempt, under peculiar circumstances, to apportion the diet so as to approximate the nervous system as near as possible to that constituting its most healthy condition. If the texture of the nervous system along with that of the other parts of the body be gradually loosened and diminished by insufficient or unwholesome food or poison, the body cannot be sustained under fatigue and disease. An attempt to harmonise the nourishment with the condition of each individual may influence the nervous system not only so as to produce agreeable feelings, but to avert various diseases and prolong life.

Stimulating drink is apportioned to man for accommodating him to the harassing circumstances to which he is frequently exposed. A moderate use of it promotes the functions of the nervous system in the languid and debilitated, but injuriously excites it in the ardent and robust. In languid persons it promotes the secretions and the assimilation of all the nutrient parts of the food, which would otherwise be propelled along the intestines unchanged, or remain to irritate the splanchnic nerves and disorder the health. It becomes difficult to support very long a great action by stimulants, for in every interval of their use after a certain period, venous congestion and depression of the nervous system take place.

For animals artificially supported, heat is absolutely required for maintaining the active functions of the nervous system, but a smaller quantity suffices in some animals more than in others. It is probable that it becomes combined with the nervous element; the nerves perceive it, are stimulated by it, and then excite the blood-vessels and other structures. It is the greatest in animals having large brains, and the most extensive and perfect respiratory and circulating organs; the size of the nerves has a considerable influence on its production, for the skin of the face, hands, and feet, has great power of withstanding cold. Cold may depress and even annihilate the power of the nervous element. Animals bear it differently according to their organization; those with hot blood allow the greatest variations; they are affected not only according to their structure, but also according to the quality of the nervous system; for in different kinds of the same class similarly constructed, cold is very prejudicial; whilst in others with only a slightly varied appearance, it is well borne. But even in the human body, the change from a hot to a colder climate produces a greater distinction of feeling than could have been imagined. Animals are subjected to diseases from a degree either of heat or cold to which they are not accustomed; heat produces too great an excitement, cold checks the action of the nerves in exposed parts, and those of the blood-vessels and absorbents, so that there is a slow circulation; the absorbents share in the depression whilst there is too much for them to accomplish, consequently their glands become irritated and enlarged. Many diseases accompany these states, but it is not necessary to speak of them.

However well the nervous system may be supported by blood, food, and warmth, its functions are not freely performed for any length of time without exercise; this tends not only to maintain its integrity and give full power to its organisation, but to produce that exalted state of its more essential parts, constituting the feeling of health and comfort. The generality of animals which are properly matured, have a greater or less desire of exercising and supplying themselves with food. When these faculties are equally balanced, the health of the body is the most surely maintained, otherwise a superabundance of blood is generated, and if not easily converted into fat, is determined to the organs most particularly employed, so that in a person of sedentary habits, the nervous centres, and especially the viscera of the abdomen, receive the greatest proportion, whilst the limbs have a slow circulation; but if the exercise be too excessive and the supply of food insufficient, debility and diseases depending on this are produced. The functions of the animal parts of the nervous system suffer from a want of exercise more in the higher classes than the lower; for amphibia generally do not seem to require it much. If a large animal, and more particularly man, has powerful circulatory organs, and capacious respiratory ones, very stimulating blood is propelled through the arteries, but more or less energetically according to the manner in which each part is excited. Exercise circulates the blood briskly over the body even to the minutest arteries and nerves, and quickens its return through the veins to the lungs, the action of which is increased as well as that of the heart. In this way the nervous centres and viscera are relieved from a determination of a superabundant quantity of blood to them, and the nerves and other structures of the trunk and limbs are invigorated; without it there is a general languor. Man excites his brain by mental exertion, and if he feeds highly he produces a greater determination of blood to it than it can bear long with impunity. If animals are highly fed without exercise, they do not suffer in an equal degree, as they are not elated or depressed by the same mental endowments and emotions. Different kinds of exercise must be used according to the peculiarities of each individual; if it be too great and weakening, the lungs are oppressed by an exhaustion of the nervous element, and cannot therefore dispose of the returning blood, so that if perspiration does not break out, the viscera are overpowered, and may have the foundation laid for some change in their organisation. When the extent of the muscular and cutaneous systems is considered, and the quantity of nerves received by them, it may be readily conceived how great an excitement or depression may be produced, and how much the body may be either invigorated or disordered by moderate or excessive exercise.

Exercise can be borne for only a limited time before the body must have rest. By exertion the nervous element becomes exhausted, and although nourishment and stimulants may replenish it to some extent, they supply very imperfectly the place of sleep, in which there is an absence of all sensation, and the mind is entirely in oblivion. During quiet sleep every part of the nervous system, except the par vagum, the sympathetic and such nerves as assist in respiration, are at rest. The lining membrane of the abdominal viscera is principally supplied by the sympathetic, and that of the lungs and stomach by the par vagum; it has therefore in each a modified perceptibility. Too much sensibility of these parts would have prevented sleep, as it does even under their present condition, when either acrid or stimulating food has been immoderately eaten, or when the skin is not in an agreeable state of warmth, except in insensibility from cold, and in the torpid season of some animals. Too much sleep diminishes the energy of the nervous system, and renders the body incapable of exertion; it encourages venous congestion, and in time so favours the determination of blood to the head that enlarged vessels encroach upon the space occupied by the brain.

Neither the quality nor structure of the nervous system will account for the great variations in the economy of many animals with respect to sleep. Even in some instances of mammalia, although there be not much change in the centres or their nerves, life continues during the state of inaction at particular seasons. In the torpid state of animals the heat is diminished, respiration and circulation are very slow, and food is not required, so that all the vital powers appear to subside together.

Each animal according to its structure is endowed with a greater or less tenacity of life under privation, injury, and disease. There is not only a special time for its existence, but it undergoes various changes from its birth to its decay. These may appear to be fortuitous circumstances, but they are connected with the organisation, and upon the care taken to keep this healthy, the continuance of life even for the allotted period depends. The particular state of the organs of every class and almost every species of animals, the variations in the quality and structure of the nervous system, the quality of the blood and the difference of respiration, and the uncertain supply of the most wholesome food, lead to a modification in the diseases to which animals are subject, and make the effects of some medicines almost peculiar in each. Although the same number of abdominal viscera exists in mammalia, they are different in form and structure; and although supplied by similar nerves, these have an appropriate arrangement, and some difference of quality. It may therefore be presumed that a modification of treatment must be required for the diseases of every species of animal; for in man alone, with the slight deviations of structure in many individuals, the forms of the same disease and the effects of the same medicine are extremely various.

It is probable that the nervous system is affected by all medicines, either primarily through contact with some part receiving the terminal nervous filaments, or secondarily through the fluids. They may increase or lessen the activity of the nervous element and of the medullary matter, or of particular parts of this and some of the nerves proceeding from it; or of the ganglia and nerves of the sympathetic; they may affect the nerves of particular organs. It is probable that the essential parts of medicines have properties quite opposed to, or approaching in various degrees, the essential part of the nervous system.

Medicines produce a decided change in the nerves themselves, as after the exhibition of mercury and arsenic. Some affect particular parts on account of the quality of the nerves; but the same may influence different organs, and from the varied painful sensations attending its action in each, the other structures, as well as the nerves, may in some degree determine the effect. It is very probable that the influence of any medicine is modified both according to the structure of each part of the nervous system and the organs receiving the nerves; so that some affect the nervous element powerfully and generally, but others not at all, unless through particular structures, and then the effects are modified by the condition of these.

It is difficult to consider things divested of their external characters, and resolved into their essential active properties separated from the several organic constituents, and in this state acting upon each other. If the nervous element, however, takes an important part in the healthy condition of the animal economy, it does also in the diseased. If, for its maintenance in the healthy state, it requires the essential part of the blood and chyle, it may in its diseased be approached only by the essence or active principle of medicines derived from a substance which has either been decomposed by the stomach or by some previous process. Ethereal vapours are received by the essential part of the olfactory nerve, light by that of the optic, and for other things the various nerves have a predilection according to their form and origin. Alimentary substances reduced to chyle are not absolutely necessary for keeping up the circulation, but spirits and exhalations from stimulating or narcotic substances or fluids suffice for combining with the nervous element.

In the preceding observations, the diseases of the material organs and the nervous element have been considered, and the manner in which medicines tend to remove them; but those of the instinctive essence and their remedies still remain to be noticed. The nervous element when disordered is restored by the essential part of medicines in a manner analogous to that of one gaseous element corrected by another. When the instinctive essence is disordered by the derangement or the presence of an inordinately large or deficient quantity of the nervous element, or through the morbid condition of organs, it will be restored by medicines which influence them. When however it is affected primarily through the passions, it is only through the particular countervailing forces of these that it can be corrected.

In animals, the appetites have been reduced to laws not only by a peculiarity of organisation, but by the limited means of gratifying them. It is the same with the savage, but not with civilised man. The nervous element and the instinctive essence in animals alone are implicated by them, but in man the mind is also; in the former, impressions are transient; in the latter, the mind is always reviving the evanescing images and reacting on the body. The health in animals is not therefore so easily interrupted, nor in the savage; in civilised man however the mind is open to artificial desires and numerous exciting powers, which influence and impair the functions of the organs of the body, unless they are perpetually counteracted by moral exertion. A moderate discipline of the mind, modified with the degree of its cultivation in learning from childhood, is therefore necessary to the maintenance of the perfect functions of the nervous system and the health of the body throughout life.

The will, the sensorium, the sympathetic nerve, and the organs of the body, may be immoderately excited or depressed by a too abundant or a too scanty supply and use of those things necessary for their healthy condition, and changes in the organisation of the nervous system may be the consequence. From observations made in various states of health and disease, the nerves and ganglia must be considered to be generally larger in the robust, and smaller in the attenuated. In some morbid conditions the neurilema may be inordinately thickened by inflammation, but from a more gradual and continued excitement, and particularly in the vigorous, the medullary fibres as well as the neurilema have appeared to increase in size, and to be thus enabled to confer an augmented power on the parts supplied. Nerves which have been subjected to a long-continued stimulus may even on its removal have undergone some permanent modification, which may not often be appreciable on examination, although it has modified their faculties. This acquired degree of perception in many instances more or less deeply impresses the mind, which can then excite the organ and nerves, so that complicated changes are produced, and it becomes difficult afterwards to restore these to their primitive quiescent condition.

The nerves and ganglia not only derive increased powers from healthy excitement, but they are diminished by contrary means, and if this state be continued very long, they are with great difficulty restored to the possession of their former power. The brain partakes of changes from exciting and depressing causes, and becomes so fully evolved as to occupy all the space that can be allowed for it, or it suffers more or less diminution.

It is probable that changes are continually taking place in the nervous system throughout life, but more particularly during the growth of the body, and on the completion of this process the skeleton and the brain and spinal marrow cannot advance much further. When organs have acquired their full size, the vessels and nerves mutually cease to contribute the influence which determined the action and increase. Each portion of the body does not grow in the same ratio in every animal, but it may be constrained in similar species through abnormal causes. The blood-vessels may cease to grow, but they have a particular controlling power, which is imparted through the nerves, and there must also be a stimulus for these. The impregnated living germ excites the spermatic and uterine nerves, and these the accompanying blood-vessels, for as soon as the embryo dies the action of both is diminished. A stimulus is required for insuring the perfect functions of other parts, for if the quantity or quality of the food be improper, the energies of the nerves and blood-vessels of the digestive organs are impaired, and, if this change be continued long, the organs themselves are unfitted for a sudden reception of the previously accustomed supply, or they may never recover their primitive powers.

The living germ may excite the uterus and its nerves and vessels, and thus insure a copious supply of blood, but not in the exact proportion for restraining its growth. A nidus or bed fit for growth exists in the living germ, and is excited into activity through its proper stimulus. The limitation of increase can only be accounted for by the presence of some especial power, as that of the instinctive essence combined with the nervous, which exists in an ordained quantity, and, in the first instance, excites to action the various parts of the germ about to become the perfect body, consistently with the mechanical laws to which they must be also subjected. In the mature body the mere nerve is not sufficient for limiting growth, or those of the largest size would tend to augment beyond all measure the parts they supply. Some share, therefore, of the instinctive essence has been communicated to each nerve as well as the brain, spinal marrow, and ganglia, and is afterwards continued through these, and undergoing some diminution or increase. The instinctive essence will not allow of any enlargement or action, either of the centres or particular nerves, beyond a certain degree, without producing pain or other disturbance, and thus deranging the functions of the nutritive organs, and checking the tendency to enlarge by diminishing the formation of fresh blood. Exceptions are, however, to be made for parts intended for increase, as fat, the hair and horns, the uterus, and other organs. Animals may grow in a quicker time by being freely supplied with nourishment. There may also be exceptions in gigantic productions, but then all the parts increase in the same proportion, so that there may have been an inordinate quantity of the instinctive essence from the first along with enlarged proportions of the germ. Mere vitality does not limit growth, for a tumour increases beyond all measure. The nerves can influence it to some extent, but there is a more availing power. When parts have arrived at maturity their texture tends to restrain any attempts at an undue enlargement, unless they have acquired a morbid condition. There are, however, some exceptions.

The predetermined condition of the germ has a considerable share in the mode of its evolution, which is first directed through the instinctive essence and by this through some portions of the nervous system. It is not improbable that the quicker or slower progress of growth in different creatures, depends on a greater or less disposition in the various textures to extension, but especially in the vascular system, and that this capability in the arteries, together with their favourable arrangement, may allow the increase of several structures they supply, and particularly of portions of the centres and nerves, which then direct the growth of other organs. At length the centres arrive at maturity and are proportioned to the instinctive essence, and the various parts are permitted to increase to correspond with portions of these. The growth of some organs depends upon external circumstances. But notwithstanding the perfection of the nervous system and the body generally, any interference with the instinctive essence, as from castration or other violence, will influence various parts, and thus shows that the nervous system alone is not capable of determining growth.

The periodical enlargement of parts in various animals, as in the sexual organs, and the hair and horns, is one of the most curious provisions of nature. This change depends upon the construction and disposition of organs for receiving an impulse from natural agents, which contribute to the general enjoyment of the animals, and finally to their propagation. It is not improbable that seasons and circumstances attending these, as changes of the atmosphere, heat, the use of particular food, and the gradual increase of the circulation at a certain point, may more directly influence the reproductive organs in some animals; whilst in others the same parts may be brought into activity in a different manner, but through modifications of the same means, so that they may be dependent on a congested state of the veins from a long previous repletion. When animals have had a large supply of food, and the increased quantity of blood has been expended in the accumulation of fat, and several of the organs have been excited to their utmost limits, other organs which are more quiescent, in their turn have an inordinate quantity of blood determined to them. It is difficult to conceive that the nervous centres direct these periods of excitement, independently of other circumstances. The change begins in the nutritive organs, from which the genital are insulated in a considerable degree. The heat and more abundant nourishment in the spring may easily affect the most sentient nerves, and promote the growth of the horns and hair, whilst the accumulation of flesh, and an excited or congested state of the blood-vessels, and particularly of the chylopoietic viscera, may in autumn determine the blood to the reproductive organs, and at the same time to the brain. It is therefore to be presumed that the quality of the nervous system, and probably also of the blood, are not only different in various animals, but are modified by the arrangement of the nerves and vessels in several parts of the same, and that particular portions, along with the organs they supply, are more easily excited than the rest, and thus give rise to periodical influences and changes.

Some external organs have a great power over the body, independently of the brain and spinal marrow. Castration appears to change the modelling faculty of the blood-vessels and absorbents, and at the same time modify the nervous system generally, but some parts of it more than others, probably in a considerable degree through the interposition of the sympathetic nerve, as well as the instinctive essence. The action of the blood-vessels is altered, for all the parts which do not diminish to a great degree or cease to be produced, become more delicate and attenuated in fabric, and to a certain extent the functions of the entire nervous system are also modified, for the animal has not the same spirits, and cannot undergo the same fatigue. A shock or check is given to the sympathetic nerve, but the absence of such important organs as the testes and ovaries, disarranges the harmony of the rest, and changes the form and actions of distant parts, which would have been more particularly influenced by their presence. Although in a young animal the organs are not in a state of activity, they maintain a particular influence in the system, which is a stimulus, exciting the energies of the sympathetic nerve towards circulating the blood, and exalting the powers of the nervous system generally, at least as far as this presides over the animal functions. Several differences will be found to exist in various animals, according to the permanent or periodical activity of these organs. It is however evident that they at all times actuate other parts, as the form and texture of the growing body depend upon their presence or absence long before their proper functions have been elicited.

Fig. 2.

Fig. 1.

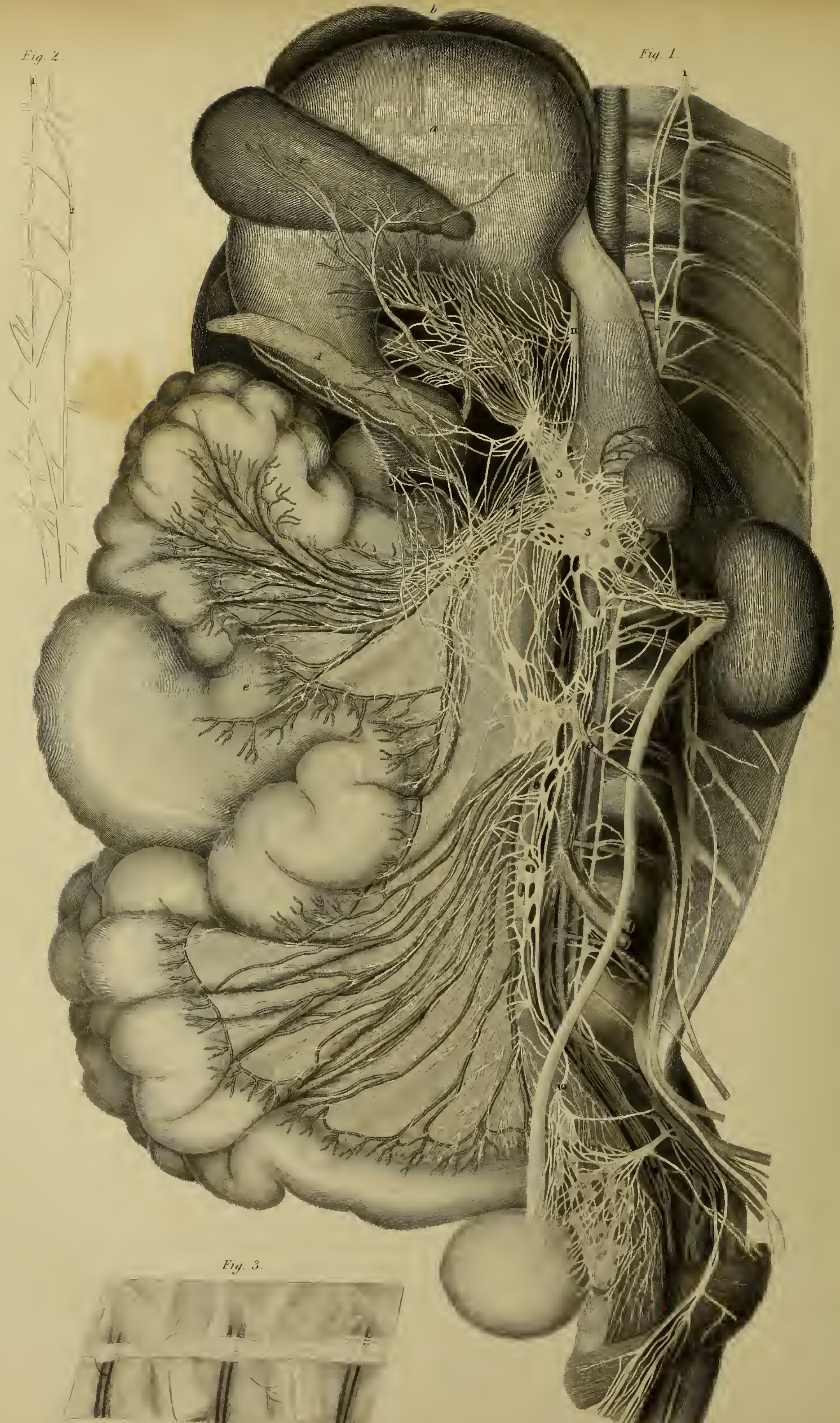


Fig. 3.

London, Published by Longman & C° 1840

PLATE XXVIII.

THE SYMPATHETIC NERVE OF THE LEFT SIDE OF A BABOON.

(SIMIA PAPIO.)

FIGURE I.

a. Stomach.

b. Liver.

c. Spleen.

d. Pancreas.

e. Termination of the ilium in the colon.

1. Prolongation of the sympathetic.

2. Great splanchnic nerve; its origin extends over the heads of five ribs; it forms a ganglion with the prolongation before it passes through the diaphragm.

3. Semilunar ganglion.

4. Prolongation of the sympathetic of each side joining on the caudal artery.

5. Cœliac plexus.

6. Right hepatic plexus.

7. Superior mesenteric plexus.

8. Inferior mesenteric plexus.

9. Internal spermatic plexus.

10. Hypogastric plexus joining branches of the sacral nerves for the bladder and rectum.

11. Posterior trunk of the par vagum giving branches to the stomach, and then joining the cœliac plexus.

FIGURE II.

THE SAME.

1. Prolongation of the sympathetic of the right side.

2. Splanchnic nerve; its origin extends over the heads of seven ribs; it expands into a ganglion, which is not however joined with the prolongation as on the left side.

FIGURE III.

THE ASS

(EQUUS ASINUS.)

The appearance of the thoracic portion of the prolongation of the sympathetic nerve before it has been disturbed.

Fig. 1.

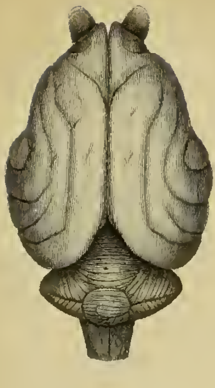


Fig. 2.

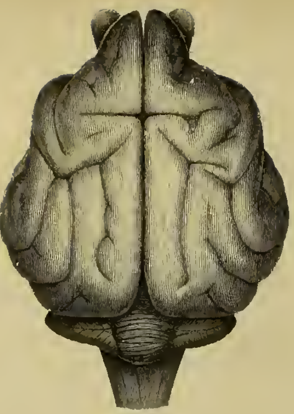


Fig. 3.

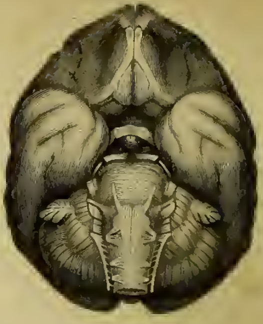


Fig. 5.

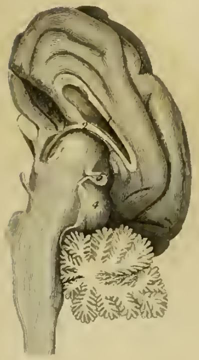


Fig. 4.

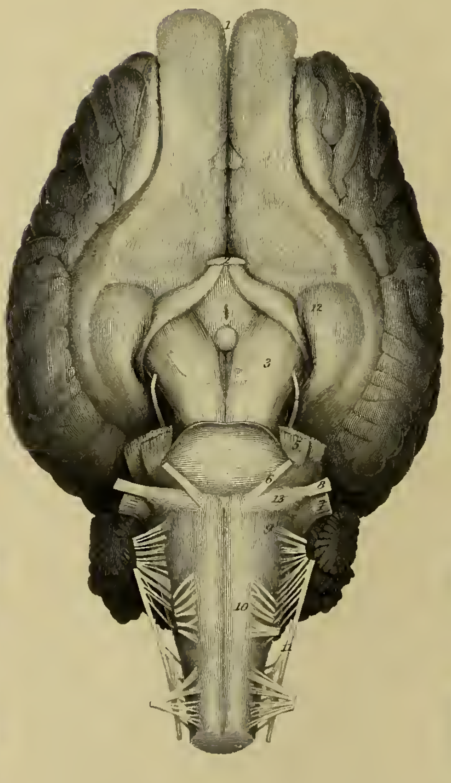


Fig. 9.

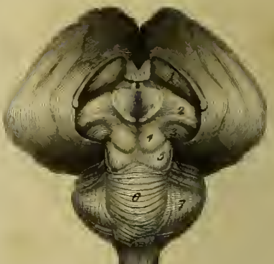


Fig. 10.

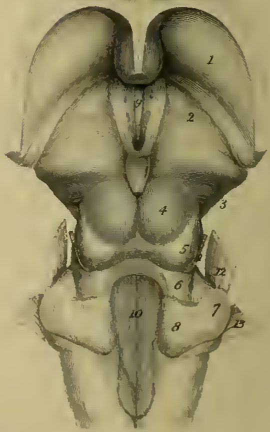


Fig 6

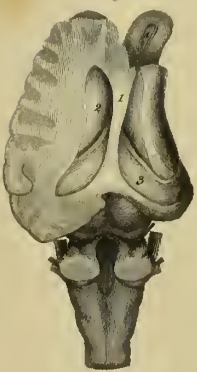


Fig. 12.

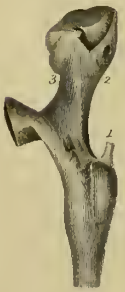


Fig. 13.

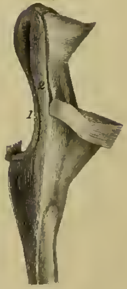


Fig II.

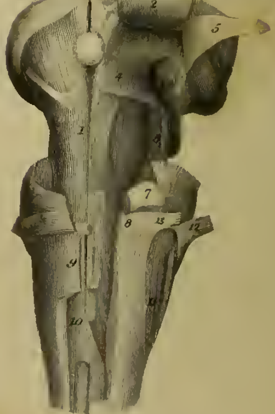
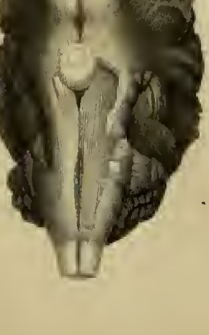


Fig. 7.



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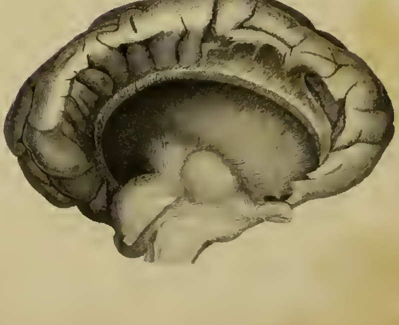

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PLATE XXIX.

THE FOX.

(CANIS VULPES.)

FIGURE I.

It shows the vertex of the brain and cerebellum, and the great breadth but small number of the convolutions of the brain.

FIGURE II.

THE DOG.

(CANIS FAMILIARIS.)

It shows the vertex of the brain and cerebellum, and its different appearance from that of the fox.

FIGURE III.

THE MONKEY.

(SIMIA.)

It shows the base of the brain and the origins of the nerves; also the small olfactory nerves; the small trapezoid bodies, the olivary bodies, and the lateral lobules of the cerebellum. The posterior horn of the lateral ventricle is not of the same small size in every species of simiæ, but varies with the size of the posterior lobe of the brain.

FIGURE IV.

THE HORSE.

(EQUUS CABALLUS.)

It shows the base of the brain, and the origins of the nerves.

1. Olfactory nerve; its origin occupies a considerable part of the surface of the base of the brain, and is connected with the inferior part of the hippocampus. It forms a large bulb, which is placed over the cribriform plate of the ethmoid bone, and terminates in branches passing through the perforations in this to the Schneiderian membrane of the nose.

2. Commissure of the optic nerves, which receives the optic tracts; these appear to be continuations from the thalami, and to be connected with the surface of the nates, the geniculate bodies, the crura of the brain, the mammillary eminence, and the part surrounding this.

3. Third nerve, arising from the inner part of the crus of the brain.

4. Fourth nerve, arising behind the quadrigeminal bodies from the superior pedicle of the cerebellum, near the roof of the passage from the third to the fourth ventricle.

5. Fifth nerve: the figure is placed on the smaller portion; it arises from the crus of the cerebellum and the annular tubercle; its origin is continued downwards to the termination of the oblong medulla, and forms a conical prominence on this; the smaller portion is on the inner side, and arises near the junction of the crus of the cerebellum with the annular tubercle: the larger portion undergoes a change in the arrangement of its fibrils in the gasserian ganglion, and is then divided into three trunks.

6. Sixth nerve, arising from the trapezoid body in the groove on the outer side of the pyramidal body.

7. Auditory nerve, arising from the side of the fourth ventricle, the restiform body, and the crus of the cerebellum.

8. Hard portion of the seventh, arising from the trapezoid and restiform bodies.

9. Glosso-pharyngeal nerve and par vagum, arising from the side of the restiform body.

10. Ninth nerve, arising a little on the outer side of the pyramidal body.

11. Accessary nerve.

12. Inferior part of the hippocampus.

13. Trapezoid body.

FIGURE V.

THE SHEEP.

(OVIS ARIES.)

It affords a side view of the brain, which has been divided at the median line.

1. Great commissure.
2. Anterior crus of the fornix.
3. Anterior commissure.
4. Nates.
5. Pineal gland.

FIGURE VI.

THE SAME.

It shows the lateral ventricles laid open, and continued into the bulb of the olfactory nerve.

1. Attachment of the great commissure to the septum lucidum.
2. Striated body.
3. Continuation of the fornix and the great hippocampus.
4. Olfactory nerve, showing the continuation of the lateral ventricle.

FIGURE VII.

THE SAME.

It shows the fibres proceeding from the pyramidal bodies, and the oblique olivary chords through the crura of the brain to the great commissure, and the convolutions.

FIGURE VIII.

THE CALF.

(BOS TAURUS.)

The brain has been divided through the median line; it shows the continuation of fibres of the crura of the brain through the striated body and thalamus to the great commissure, and from this to the convolutions.

FIGURE IX.

THE DOMESTIC CAT.

(FELIS CATUS.)

The brain has been divided through the great commissure, and the superior part of each hemisphere everted.

1. Striated body.
2. Thalamus.
3. Geniculate body.
4. Nates.
5. Testis.
6. Vermiform process of the cerebellum.
7. Lateral lobe of the cerebellum.

FIGURE X.

THE HORSE.

(EQUUS CABALLUS.)

It shows the striated bodies, thalami, third ventricle, quadrigeminal bodies, and fourth ventricle.

1. Striated body.
2. Thalamus.
3. Geniculate body.
4. Nates.
5. Testis.
6. Superior pedicle of the cerebellum.
7. Inferior pedicle or crus of the cerebellum.
8. Posterior pedicle of the cerebellum.
9. Third ventricle.
10. Fourth ventricle.
11. Fourth nerve.
12. Fifth nerve.
13. Auditory nerve.

FIGURE XI.

THE SAME.

1. Crus of the brain of the left side, which is perfect.
2. Crus of the brain of the right side divided and turned up.
3. Superior layer of the oblique olivary chord passing at the base of the nates.
4. Inferior layer of the oblique olivary chord, passing to the crus of the brain.
5. Optic tract turned up.
6. Nates.
7. Annular tubercle divided.
8. Trapezoid body.
9. Outer layer of the left pyramidal body.
10. A more inner layer of the left pyramidal body, crossing the right.
11. Origin of the larger portion of the fifth nerve from the oblong medulla.
12. Auditory nerve.
13. Hard portion.

FIGURE XII.

OBLONG MEDULLA.

(HUMAN.)

It shows the oblique olivary chord spread over the side of the oblong medulla, and extending superiorly to the nates and thalamus, and inferiorly to the crus of the brain.

1. Pyramidal body cut short.
2. Layer of the oblique olivary chord, passing to the crus of the brain.
3. Layer of the oblique olivary chord, passing to the base of the nates.

FIGURE XIII.

THE SAME.

It affords an opposite view of the same preparation.

1. Median edge of the oblique olivary chord.
2. Ventricular chord.

Fig. 1

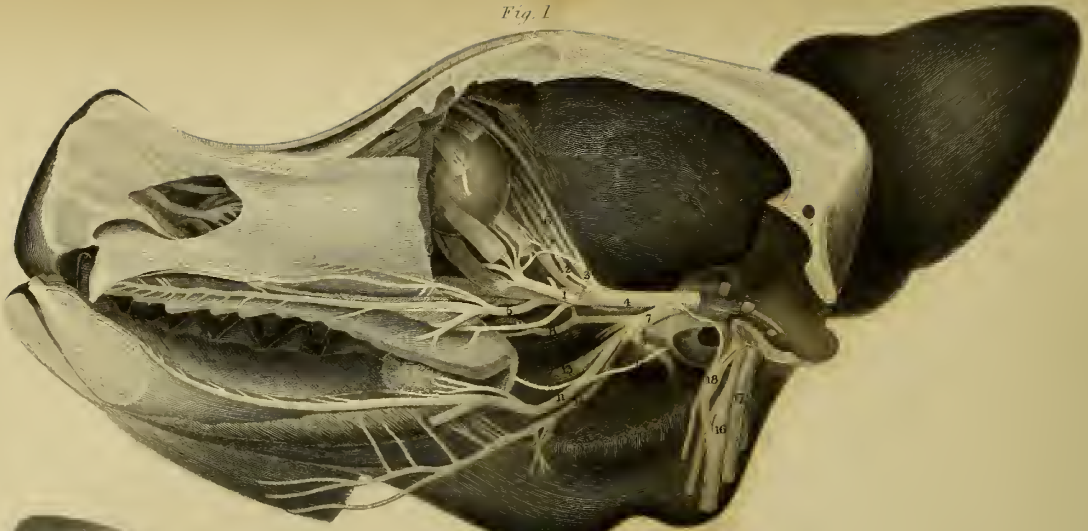

Fig. 2.

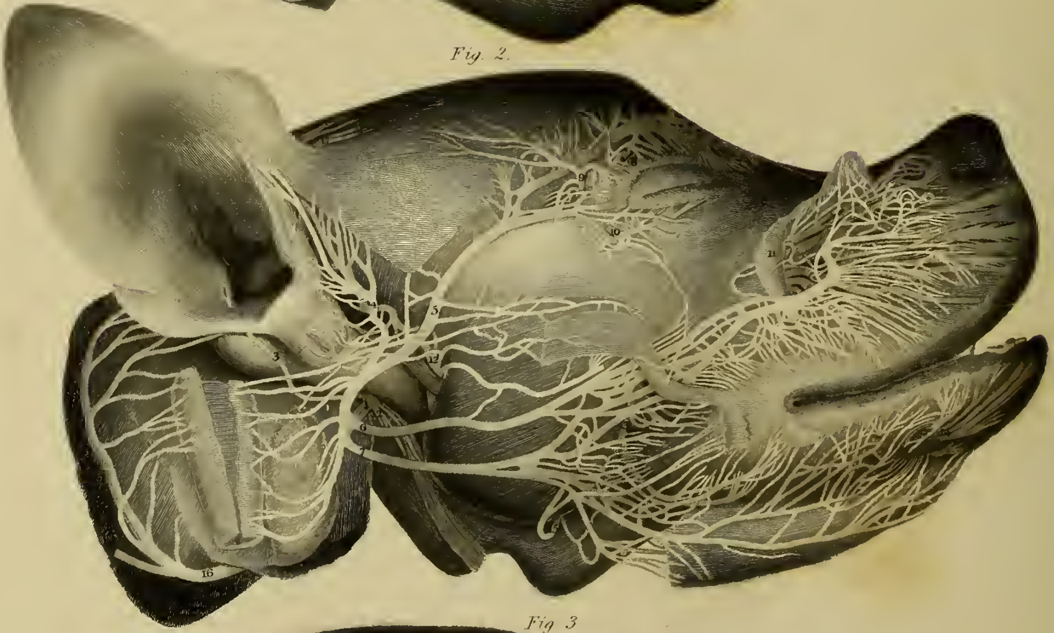

Fig 3

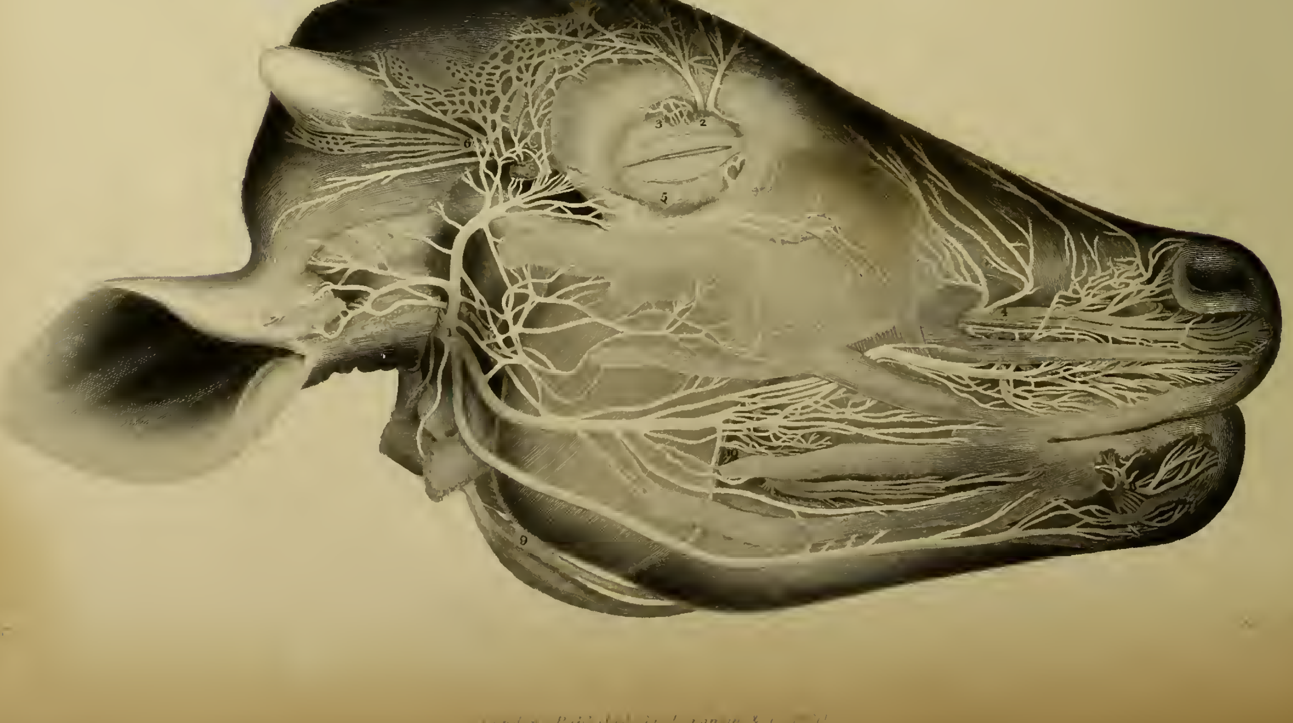

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PLATE XXX.

THE DOG.

(CANIS FAMILIARIS.)

FIGURE I.

1. Third nerve, giving branches to the muscles of the eye and the lenticular ganglion. The fourth nerve and the superior oblique muscle have been cut short.

2. Sixth nerve.

3. First trunk of the fifth.

4. Second trunk of the fifth.

5. A branch from the second trunk of the fifth, dividing into the palatine and lateral nasal nerves.

6. Malar nerve from the second trunk of the fifth, dividing into the temporal and malar.

7. Third trunk of the fifth.

8. Buccal nerve.

9. Anterior aural, or superficial temporal nerve.

10. Deep temporal nerve.

11. Gustatory nerve cut short, but the branch, passing forward to supply the lining membrane of the mouth, has been preserved.

12. Chord of the tympanum.

13. Inferior dental nerve.

14. Mylo-hyoideal nerve, arising from the inferior dental; it supplies the lower belly of the digastric muscle, the mylo-hyoideal, and the cutaneous muscle, and sends two branches into the face, to join branches of the hard portion.

15. Two branches of the mylo-hyoideal nerve to join the hard portion in the face.
16. Ganglion of the par vagum.
17. Accessary nerve.
18. Superior cervical ganglion of the sympathetic nerve.

FIGURE II.

THE SAME.

1. Hard portion of the seventh.

2. A branch of the hard portion for the superior belly of the digastric muscle and the stylo-hyoideal.

3. A branch of the hard portion, piercing the cartilage of the concha, and terminating on the skin lining this.

4. A branch of the hard portion given to the muscles of the external ear; it is joined by the superficial temporal, or auricular branch of the third trunk of the fifth: these, after approaching each other, form a very slight communication, and separate again to be distributed on the muscles and skin of the external ear.

5. Temporal branch of the hard portion continued over the eyebrow to the cutaneous muscle of the forehead and nose, and the orbicular muscle of the eyelids; it communicates with the superficial temporal of the third trunk of the fifth, with the temporal and malar branches of the malar nerve, and the supra-orbital.

6. Middle branch of the hard portion, passing towards the upper jaw, and communicating with the buccal and the second trunk of the fifth, and giving branches to the muscles of the face.

7. Inferior branch of the hard portion, communicating with the buccal and the mylo-hyoideal nerve of the inferior dental, then passing towards the chin, communicating with the inferior maxillary nerve after this has emerged from its foramen, and giving branches to the muscles of the face and lower lip. Branches pass backwards from this, and the preceding branch 6, to communicate with others from the first cervical nerve distributed on the cutaneous muscle.

8. Supra-orbital nerve giving branches to the upper eyelid and the integuments of the forehead. Another branch is given off by the first trunk of the fifth, which

communicates with the temporal branch of the malar, and is then given to the lachrymal gland, the conjunctive membrane, and the outer portion of the upper eyelid.

9. Temporal branch of the malar proceeding from the second trunk of the fifth; it gives a branch to communicate with one of the first trunk of the fifth for the lachrymal gland, and then passes out at the exterior part of the orbit, communicates with a branch of the hard portion, and is distributed on the cutaneous muscle and skin of the temple.

10. Malar branch of the malar nerve arising with the temporal; it communicates with a branch of the hard portion, and is then given to the skin of the face and the lower eyelid.

11. Continuation of the second trunk of the fifth to terminate on the upper lip and nostril; this and all the other branches of the fifth in the face, communicate freely with the hard portion.

12. Auricular or superficial temporal branch of the third trunk of the fifth, giving branches to the skin of the ear and sending small branches forward to the skin and cutaneous muscle of the face.

13. Buccal nerve of the third trunk of the fifth, communicating with branches of the hard portion, and terminating on the buccinator muscle and skin of the face.

14. Continuation of the inferior dental nerve to the skin and muscles of the lower lip.

15. Two branches of the mylo-hyoideal nerve from the inferior dental, and joining branches of the hard portion 7.

16. A branch of the anterior trunk of the first cervical nerve given to the cutaneous muscle of the neck and the skin of the external ear, and communicating with branches of the hard portion.

17. Branches of the posterior trunk of the first cervical nerve; it gives branches to the cutaneous muscle of the occiput, and of the posterior part of the external ear, and to the skin.

FIGURE III.

THE CALF.

(BOS TAURUS.)

1. Hard portion of the seventh.

2. Supra-orbital nerve ; it arises with the superior nasal.

3. Nerve terminating on the outer part of the upper eyelid and eyebrow, after it has supplied the lachrymal gland ; it arises from the gasserian ganglion close to and communicating with the temporal.

4. Second trunk of the fifth.

5. Malar nerve, arising from the gasserian ganglion, and terminating on the lower eyelid.

6. Temporal branch of malar arising from the gasserian ganglion : it gives branches to the superficial muscle and skin of the temple, the greatest part of it then passes outwards to be distributed on the horn.

7. Auricular branch of the superficial temporal nerve ; the anterior branch of this nerve is seen passing forwards to join the middle branch of the hard portion.

8. Continuation of the inferior dental nerve.

9. Gustatory nerve.

10. Buccal nerve.

PLATE XXX

Fig. 1.

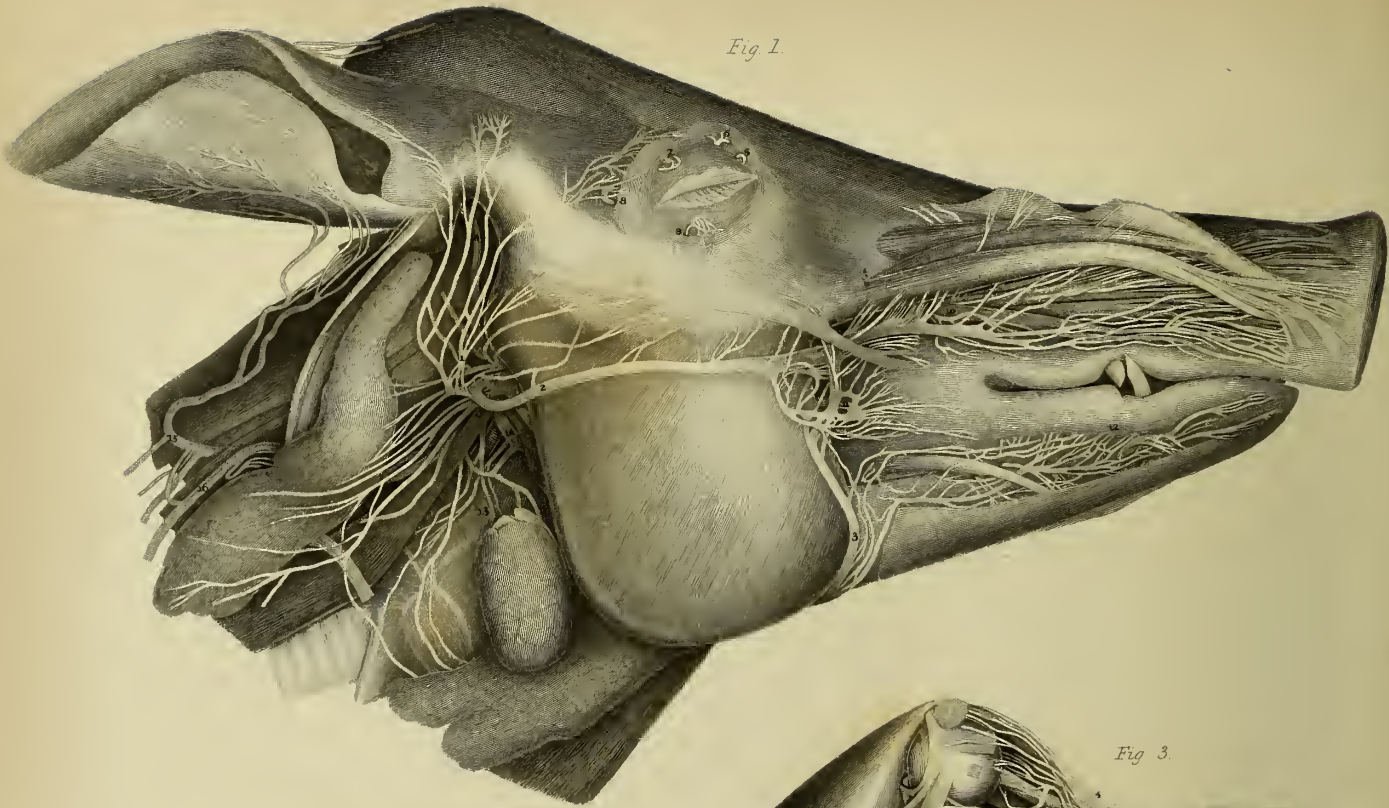
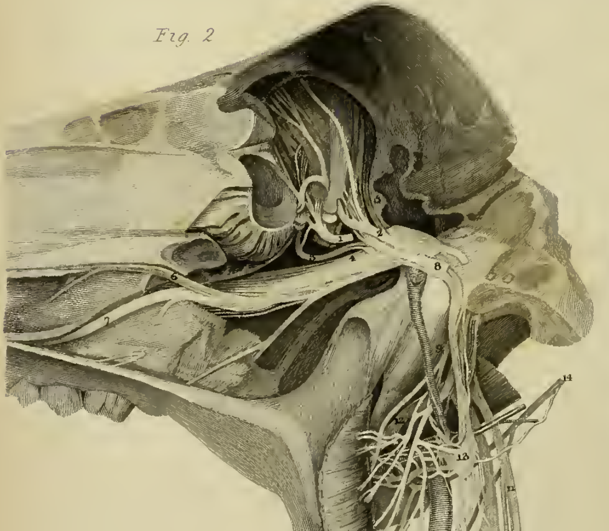


Fig. 2



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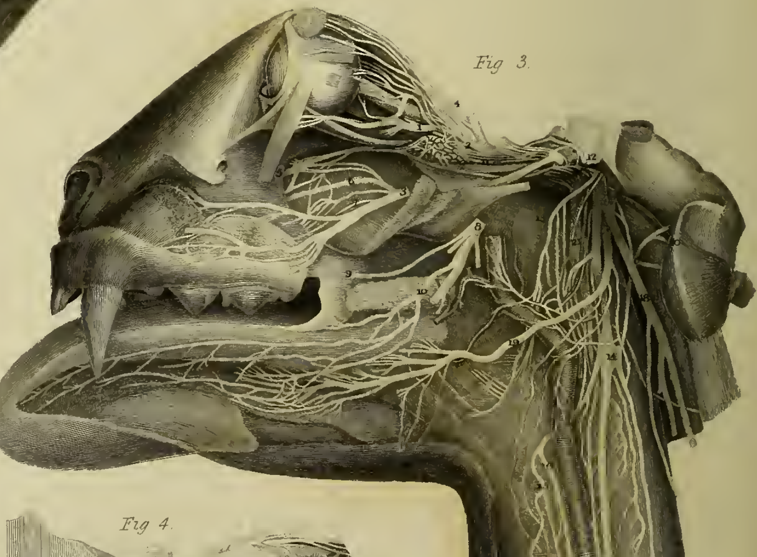

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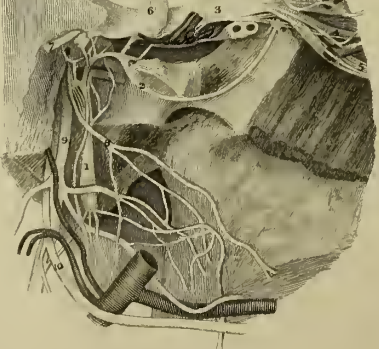

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PLATE XXXI.

FIGURE I.

THE FACIAL NERVES OF THE SOW.

(SUS SCROFA.)

1. Temporal branches of the hard portion.

2. Middle branch of the hard portion.

3. Inferior branch of the hard portion; it is seen emerging from behind the angle of the jaw.

4. A large branch of the hard portion for the muscles of the external ear.

5. Continuation of a branch of the superior nasal nerve.

6. Supra-orbital nerve.

7. Continuation of the lachrymal nerve.

8. Temporal branch of the malar nerve.

9. Malar branch of the malar, both the temporal and malar branches arise separately from the second trunk of the fifth.

10. Continuation of the superior maxillary nerve.

11. Buccal nerve.

12. Termination of the inferior dental, several smaller branches are seen coming out more posteriorly at different foramina.

13. Superior laryngeal nerve; it gives a branch to the pharynx and the crico-thyroideal muscle, and terminates on the membrane of the glottis, epiglottis, and the superior part of the larynx; it communicates with the recurrent nerve by a finer and a larger branch; the finer communicates with the branches of the recurrent passing to the posterior crico-arytenoid muscle; the larger joins a branch of the recurrent, and forms a broad and thick expansion not much unlike a ganglion, which terminates in branches

on the lateral crico-arytenoid and the thyro-arytenoid muscles; the rest of the recurrent gives filaments to the posterior crico-arytenoid, and sends a branch behind this muscle to terminate in the transverse and oblique arytenoid muscles. On the left side the nerves were much smaller. From the intimate combination of the branches from the superior laryngeal and recurrent nerves, it would seem that their properties must be similar; if there be always this large conjunction, it may be presumed that it exists for actuating the lateral crico-arytenoid and thyro-arytenoid, and that the great size of these muscles is required for preserving the open state of the glottis for counteracting any inconvenience that might otherwise arise in the fat condition of the animal, at the same time that it associates more particularly the membrane surrounding the glottis and the muscles of this part.

14. Ninth nerve sending a branch to join one of those proceeding from the sub-occipital to the sterno-hyoid and sterno-thyroid muscles.

15. A branch of the first cervical nerve to the skin of the ear.

16. Accessory nerve.

FIGURE II.

THE CONNEXION OF THE CEREBRAL NERVES WITH THE SYMPATHETIC OF THE SAME.

The head was divided perpendicularly at the median line.

1. Third nerve.

2. First trunk of the fifth.

3. A nerve proceeding from one branch of the first trunk placed behind the sixth, the other from the beginning of the second trunk in a spot at which a branch of the sympathetic is received; it is then joined by a branch from the third, and passes to the inferior oblique muscle of the eye.

4. Second trunk of the fifth.

5. Malar and temporal branches arising separately from the second trunk of the fifth.

6. Lateral nasal nerve.

7. Largest of the palatine nerves.

8. Sixth nerve.

9. Glosso-pharyngeal nerve.

10. Ganglion of the par vagum, sending off the superior laryngeal nerve.

11. Accessory nerve.

12. Ninth nerve.

13. First cervical ganglion of the sympathetic, sending branches upwards to the second trunk of the fifth and sixth; there is not a distinct Vidian nerve passing in a canal of bone, but the branch most resembling it may be traced on the second trunk of the fifth to the place from which the lateral nasal and palatine nerves arise; branches also proceed from the ganglion to communicate with the ninth and suboccipital and the pharyngeal plexus, and pass on the carotid artery to the salivary glands and other parts receiving the arterial branches.

14. Anterior trunk of the suboccipital nerve receiving the descending branch of the ninth.

FIGURE III.

THE CEREBRAL NERVES OF THE JAGUAR.

(FELIS ONÇA.)

1. Third nerve giving branches to the muscles of the eye, and forming the lenticular ganglion on the branch passing to the inferior oblique muscle; the lenticular ganglion sends a ciliary branch on the outer side of the optic nerve to the interior of the eye, and another to the inner side of the optic nerve, to join the branch of the superior nasal nerve, but not to form a ganglion; and from this junction other ciliary nerves pass to the interior of the eye.

2. First trunk of the fifth; the supra-orbital is cut short; the superior nasal is seen sending a branch to join the one from the lenticular ganglion to form ciliary nerves and then pass forward to send one branch into the nose, and another to terminate on the skin at the inner angle of the eye.

3. Second trunk of the fifth divided.

4. Malar nerve arising from the second trunk of the fifth, which has been divided.

5. Lateral nasal nerve receiving the Vidian.

6. Palatine nerve.

7. First superior dental nerve; the next is much larger; filaments of both pass through perforations in the superior maxillary bone to the double teeth, the rest of the large branch then supplies the large pointed tooth, passes round the fang of this and descends to the fang of the first incisor, and winds round this to supply the other two.

8. Third trunk of the fifth divided.

9. Buccal nerve; the deep and superficial temporal are cut short.

10. Gustatory nerve, the inferior dental has been cut short; it gives a branch to the lining membrane of the mouth, and then passes forwards dividing into branches, which communicate with the ninth in their course to the surface of the tongue.

11. Sixth nerve.

12. Hard portion of the seventh.

13. Glosso-pharyngeal nerve.

14. Ganglion of the par vagum.

15. External laryngeal nerve; it sends a long branch downwards, which gives filaments to the pharynx and œsophagus, and communicates with the recurrent at the side of the trachea; this on the left side is given off by the superior laryngeal: it then communicates with a branch from the superior laryngeal; it gives a branch to the crico-thyroid muscle, and sends another through a foramen in the thyroid cartilage to join the superior laryngeal descending behind the wing of the thyroid cartilage. It may be presumed from this difference of distribution in the two sides that the functions of the superior and external laryngeal nerves are the same.

16. Superior laryngeal nerve; it passes through a foramen in the thyroid cartilage and receives the preceding branch of the external laryngeal, which has passed through another foramen in the cartilage; it sends a branch downwards to join the branch of the recurrent terminating on the lateral crico-arytenoid and the thyro-arytenoid muscles, and is then distributed on the membrane of the glottis, epiglottis, and superior part of the larynx.

17. Recurrent nerve; on passing behind the wing of the thyroid cartilage, besides the preceding communications with the superior and external laryngeal nerves, it sends the branch to the lateral crico-arytenoid muscle, and the thyro-arytenoid; it gives filaments to the posterior crico-arytenoid muscle, and sends a branch behind this muscle to the transverse and oblique arytenoid muscles.

18. Accessory nerve.

19. Ninth nerve, sending off several descending branches before it passes to the muscles of the tongue.

20. Anterior trunk of the suboccipital nerve; it supplies the anterior straight and lateral muscles of the head, and after receiving a descending branch of the ninth it terminates on the sterno-hyoid and sterno-thyroid muscles.

21. Superior cervical ganglion of the sympathetic nerve.

FIGURE IV.

THE SYMPATHETIC NERVE OF THE SHEEP.

(OVIS ARIES.)

1. Superior cervical ganglion of the sympathetic nerve.
2. Vidian nerve.
3. Second trunk of the fifth.
4. Lateral nasal nerve.
5. Palatine nerve.
6. Third trunk of the fifth.
7. Hard portion of the seventh.
8. Glosso-pharyngeal nerve.
9. Par vagum.
10. Ninth nerve.

Fig. 1.

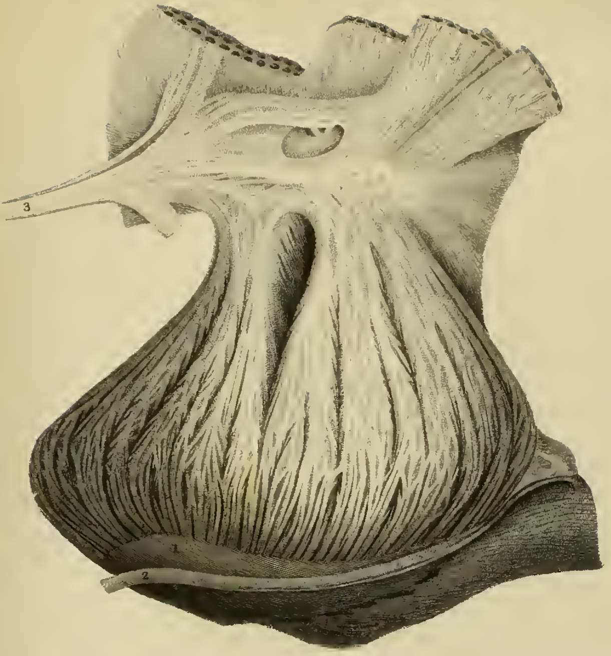

Fig. 2

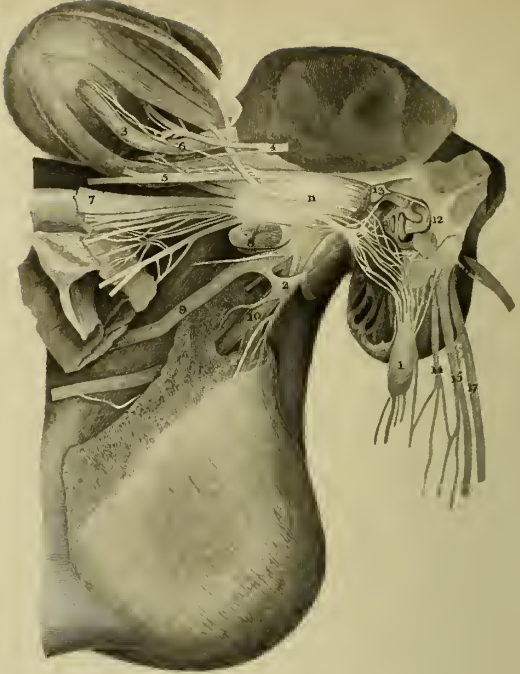

Fig. 3.

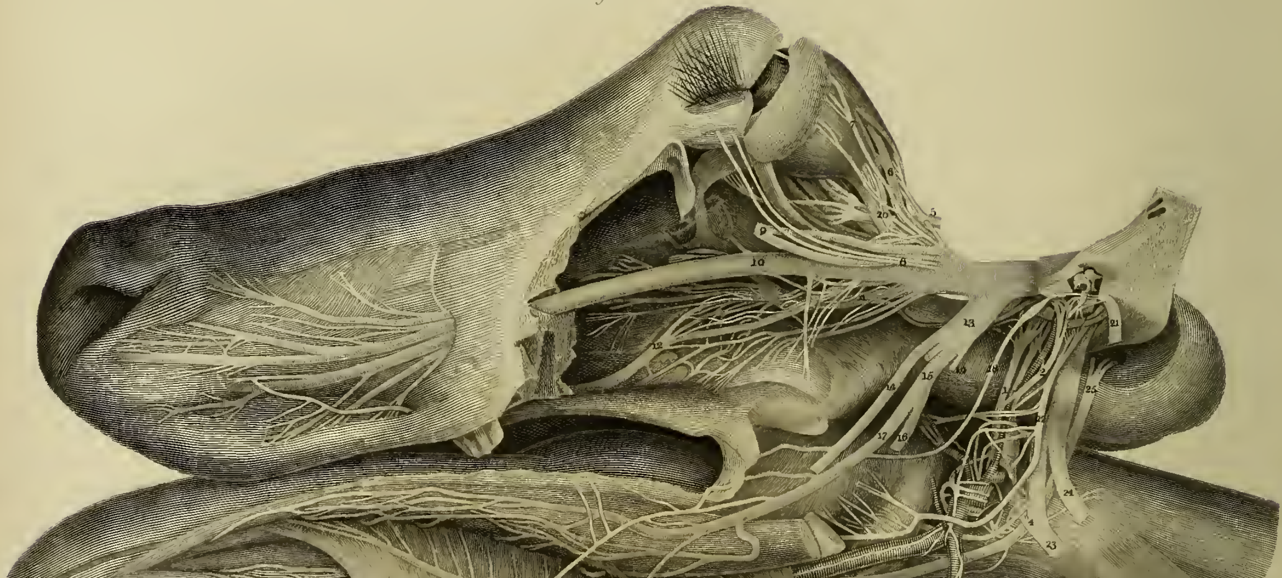

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PLATE XXXII.

FIGURE I.

THE OLFACTORY NERVE OF THE HORSE.

(EQUUS CABALLUS.)

After the nerve has passed through the cribriform plate of the ethmoid bone, and many of the branches have been distributed on the convoluted plates of this, they are again concentrated a little lower down and coalesce with the lateral nasal nerve, and then give off branches to the Schneiderian membrane covering the turbinated bones and the outer boundary of the nose, whilst others pass to the membrane covering the septum.

1. Bulb of the olfactory nerve.
2. Superior nasal nerve of the first trunk of the fifth.
3. Lateral nasal nerve of the second trunk of the fifth.

FIGURE II.

THE SYMPATHETIC AND OTHER NERVES IN THE HEAD OF THE CALF.

(BOS TAURUS.)

The head was divided perpendicularly for showing the nerves from the median plane.

1. Superior cervical ganglion of the sympathetic sending branches upwards to the Gasserian ganglion, and others to the surface of the tympanum ; it sends also filaments backwards towards the par vagum, the glosso-pharyngeal and ninth, just at their exit from the cranium.

2. Otic ganglion communicating with the buccal nerve, and the trunk giving off the gustatory and inferior dental nerves, and sending branches to the internal pterygoid muscle, and a branch along the Eustachian tube, where it divides into two, one of which joins the branches of the sympathetic in the tympanum, and the other terminates on the tympanum.

3. Optic nerve.

4. Third nerve.

5. First trunk of the fifth.

6. A branch arising from the Gasserian ganglion, near the first trunk of the fifth, at the part receiving branches from the superior cervical ganglion of the sympathetic; it passes into the orbit, and receives a branch from the third nerve to form the ciliary ganglion, from which the ciliary nerves are sent along the optic nerve into the eye.

7. Second trunk of the fifth.

8. Deep temporal nerve of the third trunk of the fifth, sending a branch to the temporal muscle, and then terminating in the masseter.

9. Buccal branch of the third trunk.

10. Large branch of the third trunk, giving off the inferior dental and gustatory nerves.

11. Sixth nerve.

12. Auditory nerve, giving one portion to the cochlea, and the rest to the vestibule and semicircular canals.

13. Hard portion of the seventh communicating with the vestibular part of the auditory nerve, and the sympathetic, and with the trunk of the par vagum, and then passing forward to supply the muscles of the external ear, and those of the face and lips, and communicate with branches of the fifth, and the superior cervical nerves.

14. Glosso-pharyngeal nerve.

15. Trunk of the par vagum.

16. A branch from the trunk of the par vagum, to join the hard portion of the seventh.

17. Accessory nerve.

FIGURE III.

THE SAME.

It shows the nerves from the exterior surface, after the removal of the lower jaw and part of the cranium.

1. Branches from the superior cervical ganglion of the sympathetic, sending branches upwards to communicate with the Gasserian ganglion, and more particularly with the part giving off the second trunk, also with the sixth.

2. A branch of the sympathetic passing upwards, and sending filaments into the tympanum to communicate with the tympanine nerve of the glosso-pharyngeal, and the chord of the tympanum on the outer surface of the labyrinth; then, like the Vidian nerve, passing forwards in a canal to join the nasal branch of the second trunk of the fifth, and assume a ganglionic appearance.

3. A branch of the superior cervical ganglion of the sympathetic, which joins branches of the glosso-pharyngeal and the trunk of the par vagum; branches are then given to the pharynx, whilst others accompany the divisions of the carotid artery to the salivary glands, and other parts on which these vessels are distributed.

4. Prolongation of the sympathetic passing to the trunk of the par vagum; it passes near to the bottom of the neck, connected with this by loose neurilema, and also by several nervous filaments.

5. Third nerve: it supplies all the muscles of the eye, except the superior oblique, the abducent, and the retractor; it communicates with a branch from the fifth in the ciliary ganglion, which sends branches along the optic nerve, and through the sclerotic coat into the eye to the choroid coat and iris; these branches are fewer and thicker than in man.

6. First trunk of the fifth, dividing into the supra-orbital and superior nasal; the supra-orbital passes out at the upper part of the orbit to the upper eyelid and integuments of the forehead; the superior nasal enters a foramen at the inner side of the orbit to pass to the cribriform plate of the ethmoid bone, then passes through one of the perforations into the nose, and divides into two branches, one of which is continued on the Schneiderian membrane at the superior part of the septum, and the other on that covering the superior turbinated bone; both give branches to the membrane near the anterior extremity of the nose, which part is supplied by branches of the second trunk of the fifth, passing into the nose just above the nostril.

7. Lachrymal nerve arising from the Gasserian ganglion with the nerve 9; it gives branches to the lachrymal gland, and sends one forward to the upper eyelid.

8. Two branches from the Gasserian ganglion, passing to the lower eyelid, and resembling the malar portion of the malar nerve.

9. A nerve corresponding with the temporal portion of the malar; it passes out at the exterior of the orbit, gives branches to the superficial muscles and integuments on the temple; the greatest part of it is then distributed on the horn. Two other branches from the Gasserian ganglion pass outwardly in a canal on the inner plate of the frontal sinus to the junction of this with the outer plate, and near the insertion of the horn.

10. Second trunk of the fifth, passing out at the infra-orbital foramen to divide into branches, to be distributed on the upper lip, the outer side of the nose, and the Schneiderian membrane at the inferior part of the nose.

11. Lateral nasal nerve of the second trunk of the fifth, receiving the Vidian nerve, and passing into the nose to the Schneiderian membrane.

12. Palatine branch of the second trunk of the fifth, communicating with the lateral nasal, and terminating on the palate.

13. Third trunk of the fifth.

14. Buccal nerve from the third trunk of the fifth; it gives a branch to the external pterygoid muscle; it then passes over the inner surface of this muscle; it emerges from underneath the anterior edge of the masseter, and divides into branches, which terminate on the buccinator muscle and skin of the face; it forms considerable communications with branches of the hard portion of the seventh.

15. A branch dividing into the inferior dental and gustatory nerves: branches are also given to the circumflex muscle of the palate, and the internal pterygoid muscle.

16. Inferior dental nerve; it sends off close to the jaw the mylo-hyoideal nerve, which passes down to supply the mylo-hyoideal muscle, and the maxillary portion of the digastric; it then enters the jaw, supplies the teeth, and emerges near the chin to divide into branches, communicate with branches of the hard portion of the seventh, and terminate in the lower lip.

17. Gustatory nerve; it receives the chord of the tympanum; it passes forward and divides into branches, which ascend to the anterior portion of the surface of the tongue, between the insertions of the genio-hyo-glossal and lingual muscles; it gives branches also to the salivary glands, and the membrane of the mouth connecting the lower jaw and side of the tongue.

18. Chord of the tympanum communicating with the hard portion of the seventh,

and in the tympanum with the tympanine nerve of the glosso-pharyngeal and the sympathetic, and passing forward to join the gustatory nerve.

19. External auricular, or superficial temporal nerve, proceeding from the third trunk of the fifth; it passes behind the ramus of the jaw; it sends a large branch forward to join the middle branch of the hard portion of the seventh; it sends a large branch backwards, one part of this passes to the inner surface of the concha of the ear, the other communicates with a branch of the hard portion of the seventh, passing to the muscles of the external ear, and then terminates on the skin near the margin of the concha.

20. Sixth nerve; it communicates with the sympathetic, and a branch of the fifth passing to the lenticular ganglion; it terminates in the abducent and retractor muscles.

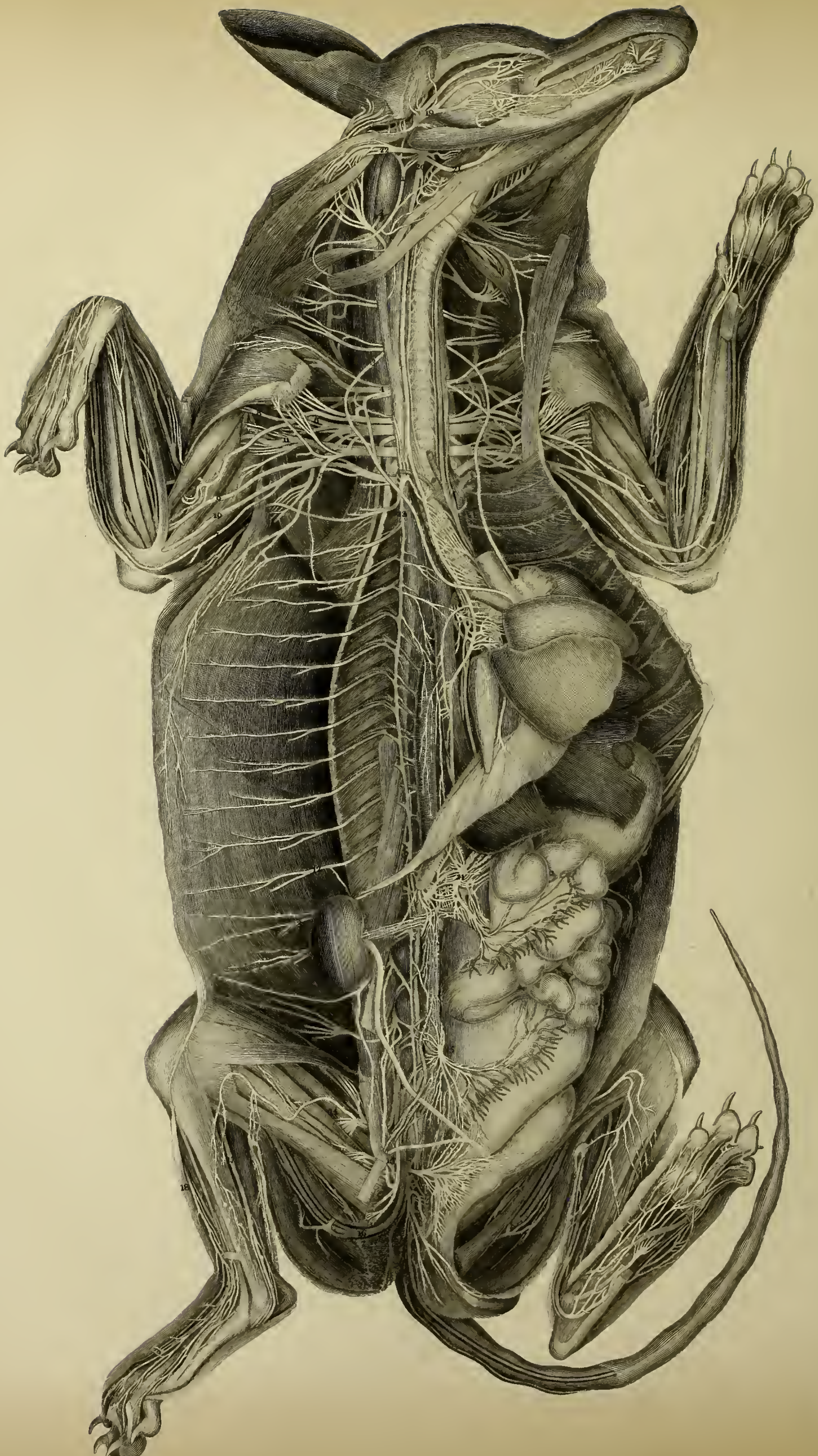
21. Hard portion of the seventh.

22. Glosso-pharyngeal nerve; it sends filaments into the tympanum to communicate with branches from the sympathetic and the chord of the tympanum; it gives branches to communicate with branches of the sympathetic and the par vagum; it gives branches to the muscles of the pharynx and the divisions of the carotid artery, and then passes forwards, distributing branches to the tonsils, the posterior part of the tongue and the membrane continued towards the larynx.

23. Trunk of the par vagum; it communicates with the hard portion of the seventh, and, soon after it has emerged from the skull, with the accessory nerve; it gives off a branch to join others from the glosso-pharyngeal, to be distributed on the pharynx; next it communicates with the first cervical ganglion of the sympathetic; it then gives off the superior laryngeal nerve to the larynx, and passes down the neck.

24. Accessory nerve; it is joined by branches of the superior cervical nerves, and is then distributed on the sterno-mastoid and trapezius muscles.

25. Ninth nerve; it sends a filament to join the anterior trunk of the suboccipital, which gives branches to the sterno-hyoideal and sterno-thyroideal muscles, and then divides into branches for the muscles connected with the hyoid bone and the tongue.



Drawn by West

PLATE XXXIII.

THE FOX.

(CANIS VULPES.)

1. Suboccipital nerve; it emerges from a foramen in the atlas; the anterior trunk passes forwards, and sends up two filaments to the junction of the trunk of the par vagum with the glosso-pharyngeal, the ninth, accessory, and the superior cervical ganglion of the sympathetic; it gives branches to the anterior straight muscles of the head, and then joins the slender descending branch of the ninth, to be distributed on the sterno-hyoid and thyroid muscles; the posterior trunk terminates on the posterior straight and oblique muscles.

2. First cervical nerve; the anterior trunks of the first and second cervical nerves give branches to the anterior straight muscles of the head, and then unite to communicate with the accessory, and divide into branches, which are distributed on the cutaneous muscle and skin, at the side of the face and neck and external ear. The third gives a branch to join the accessory and others to the trapezius muscle, and is then distributed on the cutaneous muscle and skin at the side of the neck. The fourth gives a branch to the accessory, and to the trapezius muscle, and then pierces this to terminate on the skin at the lowest part of the neck. The posterior trunk of the first cervical nerve gives branches to the splenius, complex, and other muscles, close to the posterior part of the spine, and then sends a branch through the complex towards the occiput, which gives filaments to the muscles inserted into the back of the ear, but is chiefly distributed on the skin of this part. The posterior trunk of the second, after giving branches to the splenius, complex, and other muscles, close to the posterior part of the spine, also sends a branch through the complex muscle to the skin of the occiput. The posterior trunk of the third, gives branches to the complex and other muscles close to the spine, and

then terminates on the skin. The posterior trunks of the fifth and sixth also give branches to the muscles and skin; the seventh was traced to the muscles only; the three last are much smaller than the preceding.

3. Phrenic nerve; it is formed of a branch from the fourth and fifth; it passes over the pericardium to the diaphragm, and on the right side is placed close to the inferior vena cava.

4. Fifth cervical nerve; the axillary plexus is constituted of the three inferior cervical and the first dorsal nerves, but the greatest part of the fifth, after receiving a branch from the sixth, gives a large branch to the integuments on the anterior part of the shoulder joint, and then passes to form the superior scapular nerve, and terminate on the superior and inferior spinous muscles. Branches from the fifth, sixth, and seventh cervical, and first dorsal, are given to the pectoral muscles; a branch from the sixth cervical is given to the great serrated muscle, and branches from the fifth and sixth to the subscapular.

5. A branch from the seventh cervical nerve, passing down the side to the cutaneous muscle and skin, and communicating with the external branches of several of the dorsal nerves.

6. Circumflex nerve; it arises from the union of the fifth and sixth cervical nerves; it gives branches to the subscapular and teres muscles, and then divides and sends a branch to the inferior spinous muscle and the deltoid, and branches to the integuments on the outer side of the arm.

7. Internal cutaneous nerve; it is a slender nerve sent off by the ulnar; it passes down the arm, and, near the inner condyle of the humerus, divides into branches to be distributed on the skin at the ulnar side of the fore-arm. The smaller internal cutaneous nerve is the external branch of the second dorsal after its egress from between the ribs; it pierces the broadest muscle of the back, and divides into branches to be distributed on the skin at the inner and posterior part of the arm.

8. Musculo-cutaneous nerve; it arises from the sixth cervical with the outer portion of the median, gives a branch to the pectoral muscle and the coraco-brachial, and then passes off to terminate on the biceps.

9. Median nerve; the sixth cervical having given off the nerve analogous to the usual musculo-cutaneous, the remaining part gives off a branch, which sends one back to the internal brachial muscle behind the tendon of the biceps, and then gives branches to the skin of the fore-arm, in the place of the cutaneous portion of the musculo-cutaneous in man; it then joins the branch from the seventh cervical and first dorsal nerves, about

an inch above the elbow, to form the median nerve, which is small as compared with that in man; the nerve thus formed passes under the origin of the round pronator muscle, and gives branches to this, the radial flexor muscle of the wrist, and the sublime and deep flexors of the fingers; it then passes by the side of the radial flexor and between the sublime and deep flexors underneath the annular ligament; it is continued in the hand between the tendons of these muscles, at the division of which it sends off branches; it gives filaments to the skin of the palm, and a branch to the short prominence corresponding with the thumb, and the inner side of the first finger, and a branch to be joined by one from the deep palmar for the outer side of the first finger and the inner side of the second; another branch also to be joined by a branch from the deep palmar for the outer side of the second and the inner side of the third.

10. Ulnar nerve; it is formed from the seventh cervical and first dorsal, as well as the inner portion of the median; it descends behind the inner condyle of the humerus, covered by thick fascia and by part of the sublime flexor muscle; it then passes down the fore-arm between the flexors of the fingers, and the ulnar flexor of the wrist; in the fore-arm it is much larger than the continuation of the median; it sends a branch to the ulnar side of the sublime and deep flexors, and the ulnar flexor; near the hand it sends a branch to the back of this part to communicate with the radial branch of the spiral, and then proceed to the outer side of the last finger; it passes deeply, confined by a ligament at its entrance into the palm, and sends a branch for the inner side of the last finger and the outer side of the third: the rest of the nerve forming the deep palmar divides into branches, which terminate on the interosseous and other small muscles situated in the palm, and give branches to join those of the median, sent to the outer side of the first and the inner side of the second finger, and the outer side of the second and the inner side of the third.

11. Spiral nerve; it has a slight communication with the fifth cervical, but is principally formed from the sixth and seventh and first dorsal; it gives branches to the different heads of the triceps muscle, and winds round between the inner and large heads of the triceps to the outside of the arm, and divides into two large branches; one gives off a large cutaneous branch to the outer side of the fore-arm, and then descends in the place of the radial, giving branches to the skin, and dividing to terminate on the skin at the back of the hand and the side of each finger, except the outer side of the last, and communicate with the dorsal branch of the ulnar; the other, in passing to the back of the fore-arm, gives a branch to the long and the short supinator; it is conducted between some fibres of the short supinator, and then divides to terminate in the radial

extensor of the wrist and the extensor of the fingers, whilst a long branch passes on and gives filaments to the muscles analogous to the extensors of the thumb, and to the wrist-joint, but does not terminate on this part in a ganglion as in man and the baboon.

12. Last dorsal nerve ; there are thirteen dorsal nerves, and their principal deviation from those in man consists in a smaller size, a more direct course, and a less distribution on the abdominal muscles, and by those at the lower part of the chest being covered by an extension of the origin of the psoas muscle ; and in the anterior cutaneous branches supplying the different portions of the mamma in the female dog as well as the skin : the posterior trunks, after supplying the muscles connected with the spine, and the sacro-lumbar and longest muscles of the back, send a branch between fibres of these and the broadest muscle of the back to the skin.

13. First lumbar nerve; the anterior trunks of the lumbar and sacral nerves supply principally the parts connected with the lower extremity, the bladder and rectum; the two superior of the posterior trunks of the lumbar supply the skin as well as the sacro-lumbar and other muscles connected with the posterior part of the lumbar vertebræ; the lower five the muscles only; the posterior sacral supply the muscles connected with the posterior part of the tail. The nerves are not very different from those in man except in their number, and consequently in their conjunction a little higher or lower for forming the nerves of the lower extremity. The anterior trunks of the three first lumbar nerves give filaments to the psoas muscle, and then pass forward to terminate in the abdominal muscles and skin. The fourth gives filaments to the psoas and internal iliac muscles, and sends a branch to join one from the third to form the external spermatic on the external iliac artery, which passes through the external ring to the spermatic chord ; in a female dog this was distributed on the last division of the mamma ; it sends off another branch which gives a filament to the external iliac artery and then joins the fifth, the rest of the fourth passes down on the exterior of the thigh to the skin and forms the external cutaneous nerve. The fifth receives a branch from the fourth, gives filaments to the internal iliac muscle, part of it is then joined by a large branch from the sixth to form the anterior crural nerve ; the other part after receiving a large and small branch from the sixth becomes the obturator nerve. The sixth having given off the preceding branches joins the seventh and the first sacral, and a branch of the second for forming the sciatic nerve. The junction of the seventh lumbar and first sacral, gives a branch to the pyriform muscle, and a larger one to pass out at the ischiatic notch to supply the gluteal muscles and the tensor of the fascia of the thigh. Some branches derived from the first and second sacral nerves combine with

the hypogastric plexus for supplying the bladder and rectum, and others from the pudendal nerves for the muscles connected with the anus and tail. A branch of the second sacral nerve joins the third for forming the anterior caudal nerve, which receives the anterior trunk of each remaining spinal nerve and passes deep in the anterior part of each side of the tail, giving off branches in its course ; posterior trunks of the same nerves form a posterior caudal nerve, which also sends off branches to the posterior muscles and skin of the tail.

14. Anterior crural nerve; it passes between fibres of the iliac muscle, then under Poupart's ligament at the inner side of the sartorius, it gives branches to this, the straight muscle, the external and internal vast muscles, and the crural, and sends off the saphenus, which descends across the thigh to the inner part of the leg, communicates with a filament from the obturator, and is continued to the foot, giving filaments in its course to the fascia and skin.

15. Obturator nerve; on emerging from the pelvis it gives branches to the pectineal muscle, the triceps and gracile, and sends a branch to communicate with the saphenus nerve ; several fine branches pass down on the inner side of the thigh for the fascia and integuments.

16. Sciatic nerve; on emerging from the pelvis it communicates with the internal pudendal; it sends a branch to the internal obturator muscle, and one which gives a filament to the upper portion of the geminous, and then passes behind the tendon of the internal obturator to the lower portion of the geminous and square muscles ; the sciatic passes close to the insertion of the internal obturator muscle, and upon or behind the geminous and square muscles, then behind the trochanter covered by the origin of the biceps to which it gives a branch; it sends off a large branch which divides into others for the semi-membranous and semi-tendinous muscles. About the middle of the thigh it separates into the posterior tibial and peroneal nerves.

17. Posterior tibial nerve; it sends off a long slender branch which descends on the posterior part of the gastrocnemius muscle to the outer side of the leg, sends a branch behind the tendon of Achilles to the posterior tibial nerve, and is distributed on the skin at the outer side of the leg and heel. It then gives branches to the gastrocnemius muscle, and passes between the heads of this and gives branches to the flexor of the toes, the posterior tibial and the long flexor of the great toe ; it then passes down the leg on the inner side of the tendon of Achilles, and receives the branch from the long slender branch sent underneath this tendon. It passes behind the inner condyle of the tibia, and divides into the inner and outer plantar nerves; the inner plantar gives a

branch to the inner side of the first toe, and then communicates with a branch of the deep plantar, and divides for the outer side of the first and the inner side of the second, it also communicates with a branch of the deep plantar given to the outer side of the second toe and the inner of the third; the outer plantar nerve passes between the flexor tendons, and sends a nerve to the outer side of the foot and the last toe; it gives off the deep plantar, which passes underneath the short flexor of the toes, and divides into branches, and gives filaments to each of the small muscles situated in the sole of the foot, and a branch to communicate with one from the inner plantar nerve and divide for the outer side of the first and the inner of the second, and one for the outer side of the second and the inner of the third, and another for the outer side of the third and the inner of the fourth.

18. Peroneal nerve; it gives a small branch to the biceps and filaments to the fascia near the knee; it then divides, the anterior tibial nerve sends off branches to the anterior tibial muscle, the long extensor of the toes, and the long peroneal, and descends with the anterior tibial artery, underneath the annular ligament, and gives branches to the ligaments of the foot; it passes onwards, and is joined by a branch from the continuation or dorsal branch of the peroneal, and divides for the outer side of the first, and the inner side of the second toe. The continuation or dorsal branch of the peroneal, gives branches to the short and third peroneal muscles, and passes behind the long peroneal, and emerges between this and the long extensor of the toes; it passes over the annular ligament, and sends a branch to the outer side of the foot and the fourth toe; on the back of the foot it sends the branch to join the anterior tibial nerve; it separates into two branches, the first divides for the outer side of the second and the inner side of the third toes, the other for the outer side of the third and the inner side of the fourth.

19. Hard portion of the seventh nerve.

20. Par vagum.

21. Ninth nerve.

22. Accessory nerve; it communicates with the four superior cervical nerves, and gives branches to the sterno-mastoid muscle, and terminates on the trapezius.

23. Prolongation of the sympathetic nerve.

25. Right semilunar ganglion.

26. Ganglion, giving off the inferior mesenteric and hypogastric plexuses.

In the ass, the distribution of the nerves is in some respects different from that in the fox. Several branches from the superior cervical ganglion of the sympathetic, in a plexiform manner, join the anterior trunk of the suboccipital; the small descending branch of the ninth, communicates either with the trunk or a filament from the par vagum, before it joins the anterior trunk of the suboccipital; afterwards it communicates with the pharyngeal plexus, and is then distributed on the sterno-hyoid and sterno-thyroid muscles. The nerve given to the great serrated muscle, proceeds from the fifth cervical nerve with the phrenic; but the phrenic afterwards communicates with a branch of the sixth, given to the great pectoral muscle. In the jaguar, the phrenic arises from the fourth and fifth cervical nerves, and receives a branch from the first thoracic ganglion of the sympathetic. The axillary plexus in the ass, also in the pig, is formed from the sixth and seventh cervical nerves, and the first dorsal. In the jaguar, the axillary plexus is formed of the three inferior cervical and first dorsal nerves. In the ass, the superior scapular nerve proceeds more particularly from the sixth, but in some degree from the seventh, and is given to the superior and inferior spinous muscles of the scapula. Branches proceeding from all the nerves forming the plexus, are given to the great pectoral muscle; a nerve proceeding principally from the sixth and seventh cervical nerves is given to the subscapular, the teres, and the broadest muscle of the back, and then becomes the circumflex to pass outwardly to the muscle corresponding with the deltoid, and send a branch over the external head of the triceps, to pass down the arm to the skin. Branches proceeding from the external branches of the second and third dorsal nerves, supply the skin of the arm like the smaller internal cutaneous. The internal cutaneous proceeds from the ulnar. The usual musculo-cutaneous arises principally from the sixth cervical nerve, and a small branch of the seventh; it sends a branch to the median; it supplies and then pierces the coraco-brachial muscle to terminate on the biceps. The median nerve arises from the seventh cervical and first dorsal nerves, and receives a branch from the musculo-cutaneous; it sends a branch on the outer side of the biceps, to supply the internal brachial muscle, and the skin at the posterior and inner part of the fore-arm, instead of the radial branch of the spiral, and the usual branch of the external cutaneous. The median, after supplying the flexor muscles placed in the fore-arm, sends a slender nerve close to the bone, which gives filaments to the periosteum, and passes to a muscle analogous to the long flexor of the thumb; it then passes underneath the annular ligament, and sends a large branch obliquely over the flexor tendons, to communicate with the ulnar, and descends, giving off branches to the skin at the inner side of the foot, which communicate with the inner portion of the deep palmar of the ulnar; it then passes into the foot covered by the membranous plaits attached to the hoof to terminate on these, the villous part of the sole and the ligaments of the joints. In the jaguar, the median nerve passes through a foramen in the bone of the humerus with the humeral artery. In the ass the ulnar arises from the seventh cervical and first dorsal nerves; at the middle of the arm it sends off the internal cutaneous nerve, and at the elbow gives some branches to the ulnar muscle and the elbow joint; it passes down, covered by some fibres of the flexor muscles; and at the wrist sends off the dorsal branch to the skin at the posterior and outer part of the fore-arm; it passes underneath and to the inner side of the ulnar flexor, and then underneath the annular ligament, and gives off the deep palmar nerve; it receives the branch from the median and descends, giving branches to the skin and ligaments at the outer side of the foot, after these have communicated with the outer branch of the deep palmar; it passes into the foot, covered by the membranous plaits connected with the hoof, and terminates on these and the villous part of the sole, and the ligaments of the joint. The deep palmar gives some filaments to the ligaments, and divides into two principal branches, one to pass on the inner side to give filaments to the joints, the periosteum, and ligaments, and communicate with the branches of the median sent to the skin and ligaments at the inner side of the foot, the other to give filaments to the periosteum and ligaments, and communicate with branches of the ulnar, having a similar destination on the outer side. The spiral arises from the sixth and seventh cervical and first dorsal nerves; after supplying the heads of the triceps, it passes round the humerus and gives branches to the two large extensors at the back of the fore-arm, and sends a branch somewhat expanded down to the carpal joints, but not like the ganglion in man; it then pierces the rudiment of the short supinator, to supply a muscle analogous to the long supinator on the outer side of the back of the fore-arm.

In the pig the median in the fore-arm is much larger than the ulnar, it receives a small communicating branch from the ulnar near the wrist, and then supplies the inner small toe, both sides of the first large toe, and the inner side of the second; the ulnar gives off the dorsal branch and then sends the deep palmar to the interosseous muscles; it sends the small branch to communicate with the median, and then supplies the outer side of the second large toe, and the adjoining small one. The greatest portion of the dorsum of the foot is furnished by the radial branch of the spiral and the rest by the dorsal branch of the ulnar.

In the ass there are eighteen dorsal nerves, the anterior trunks of which pass between the ribs, and are distributed nearly as in the fox. There are six lumbar and six sacral in one subject, and five lumbar and seven sacral in another, besides three or four caudal, but it is not necessary to speak of these separately. The third lumbar sends off a branch, which gives a branch to the great psoas muscle, and one to join the fourth for the anterior crural nerve, it then becomes the external cutaneous nerve to pass on the outer side of the thigh ; it sends off another large branch corresponding with the external spermatic, which communicates with a large branch of the third lumbar ganglion of the sympathetic, gives a branch to the small psoas muscle, and then passes underneath the lower border of the abdominal muscles, to which it sends a branch and becomes distributed on the mamma. The anterior crural nerve arises from the third, fourth, fifth, and sixth lumbar nerves ; the obturator arises from the fourth, fifth, and sixth ; the sciatic arises from the sixth lumbar and the two first sacral, it has also a slight communication with the third ; the principal part of the third and fourth sacral joined by a small branch from the portion of the sciatic arising from the second form a junction, which gives off the internal pudendal to pass at the side of the arch of the pubes and distribute filaments to the neck of the bladder, and terminate on the clitoris, vagina and external parts, and the connecting muscle and membrane between these and the mamma ; a branch of the external spermatic may be traced downwards, and a branch of the internal pudendal upwards towards each other, but their communication was not made out ; the rest of this junction communicates with another nerve formed by part of the fourth and fifth, and sometimes part of the sixth, branches are then given to muscles connected with the vagina, anus, and tail, and to the skin ; another part of the junction of the fourth and fifth, with sometimes a branch from the sixth, joins the hypogastric plexus, and sends branches along the inferior uterine artery to the neck of the uterus and vagina, and is then distributed on the bladder, urethra, vagina, and rectum. The remaining part of the fifth or sixth sacral forms the beginning of the anterior caudal nerve, to which the anterior trunks of the remaining spinal nerves below it become united ; the posterior trunks of these nerves form the posterior caudal nerve, both of these are continued to the extremity of the tail, communicating by branches, and supplying one half of each anterior or posterior surface. In the jaguar the anterior and posterior caudal nerves are formed in a similar manner, after these have received all the spinal nerves they are continued to the extremity of the tail, giving off branches in their course. In the ass the gluteal nerves are sent from the sixth lumbar and first sacral at their junction with the sciatic, and terminate on the gluteal muscles and the tensor of the fascia of the thigh. A nerve given off from the sciatic, supplies the slender geminous, and is continued down to another muscle approximated with the great head of the triceps ; it is analogous to the square muscle, although it is so different in shape, and is supplied by the nerve always furnishing branches to the geminous. The anterior crural nerve supplies the sartorius and the other muscles in the place of the straight, the vast, and crural ; the saphenus descends with the vein giving numerous filaments to the ligaments and skin, and communicating at the side of the foot with the inner branch of the deep plantar nerve, and through this with a branch of the inner plantar to be distributed on the skin at the side of the foot. In the jaguar the saphenus nerve is very large, and in the baboon it appears much larger in proportion to the size of the limb than in man. In the ass the obturator nerve supplies the adductors and the large muscle corresponding with the gracile. The sciatic nerve gives branches to the muscles which are in the place of the semimembranous, semitendinous, and biceps, it then divides into the posterior tibial, and the peroneal, both of which give branches to the biceps. The posterior tibial sends a branch down at the back of the gastrocnemius muscle, and on the outer side of the tendon of Achilles to the fascia, &c., on the outer side of the heel or part corresponding with the heel bone; it then passes between the heads of the gastrocnemius muscle, to which and the large muscle in the place of the posterior tibial and the flexors of the toes it gives branches; it descends on the inner side of the tendon of Achilles, giving branches to the fascia &c. on the inner side of the heel and ancle; near the heel it divides into the inner and outer plantar nerves; the inner sends off a large branch obliquely over the flexor tendon to join the external plantar nerve; it passes down on the inner side of the tendon giving branches to the sheath, fascia, and integuments; near the foot it gives off a large branch, which communicates with the inner branch of the deep plantar nerve to be distributed on the skin at the inner side of the foot; it gives branches to the skin of the heel, and then passes into the foot, covered by the membranous plaits connected with the hoof, and distributing branches to these and the villous covering of the sole. The external plantar passes between the flexor tendons, and then on the outer side of these, and gives off the deep plantar nerve; it is continued down on the outer side of the tendon, gives filaments to the sheath and fascia, receives the branch from the inner plantar, and gives off a branch which communicates with the outer branch of the anterior tibial nerve, and is distributed on the side of the foot; it gives branches to the skin of the heel and then passes into the foot covered by the membranous plaits connected with the hoof to distribute branches to these and the villous covering of the sole. The deep plantar gives filaments to the ligaments, &c., and then divides into two branches; the inner passes down underneath the tendon, then near the edge of the bone to the foot to communicate with a branch of the saphenus nerve, and of the inner plantar, to be distributed on the skin at the inner side of the foot; the outer branch passes near the edge of the bone, gives a branch to the ligaments, and then joins the outer branch of the anterior tibial nerve. The peroneal nerve passes to the outer side of the leg, and gives small branches to the fascia and skin; it sends the long branch downwards, which gives filaments to the fascia, and terminates in the skin covering the dorsum of the cannon bone. It gives filaments to the ligaments and fascia on the outer side of the knee joint, and branches to the peroneal muscle, the extensors of the toes, and the anterior tibial muscle. It gives off the anterior tibial nerve, which passes down the leg between the peroneal and anterior tibial muscles, then between this and the bone along with the anterior tibial artery underneath the annular ligament, where it divides into two branches, the outer one gives filaments to the joint, and is continued with the anterior tibial artery on the outer side of the cannon bone, giving filaments to the periosteum, and on the outer side of the foot receiving the outer branch of the deep plantar nerve: it then becomes connected with a branch of the outer plantar nerve, and is distributed on the ligaments and skin on the outer side of the foot; the inner branch of the anterior tibial passes down on the cannon bone, gives filaments to the periosteum and fascia, and terminates on the skin at the inner side of the foot.

In the pig the posterior tibial nerve having given branches to the muscles of the leg, and sent the branch down at the back of the gastrocnemius muscle to the outer side of the leg, gives filaments to the inner side of the heel, and near this part divides into the inner and outer plantar nerves; the inner is continued onwards and supplies the small inner toe, and the first large toe, and the inner side of the second. The outer plantar passes underneath the flexor tendons, and is continued onwards to divide for the outer side of the second large toe, and the outer small toe; it sends the deep plantar into the sole to supply the short muscles situated there. The anterior tibial nerve gives branches to the ligaments at the back of the foot and sends a branch to supply the first small toe and the inner side of the first large one, the rest of it gives branches to the small muscles on the back of the foot; and then passes forward to join the branch of the peroneal given to the outer side of the first, and the inner side of the second large toe; the continuation of the peroneal after emerging just above the instep supplies the outer side of the first large toe, both sides of the second, and the last small one, the branch sent to the outer side of the first and the inner side of the second large toe, receiving a branch of the anterior tibial.

Fig. 1.

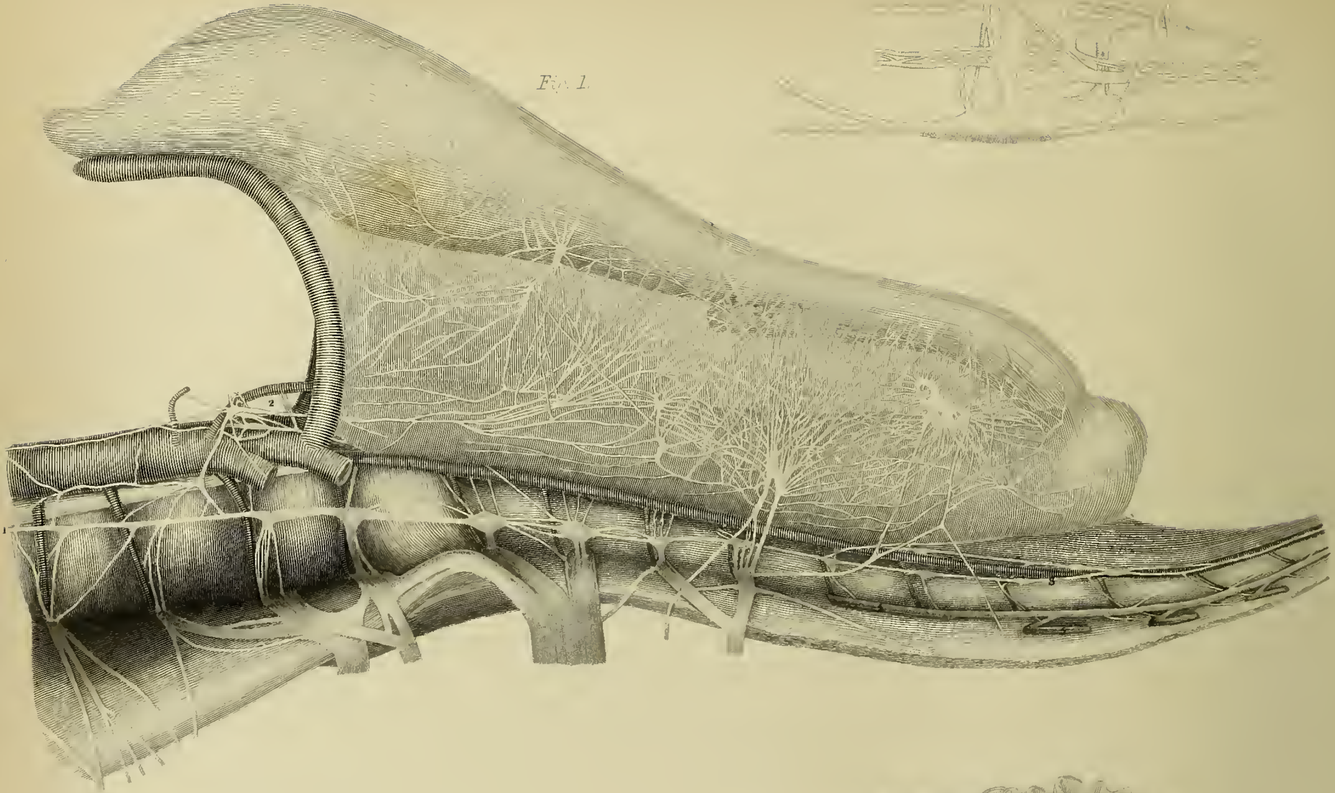


Fig. 2.

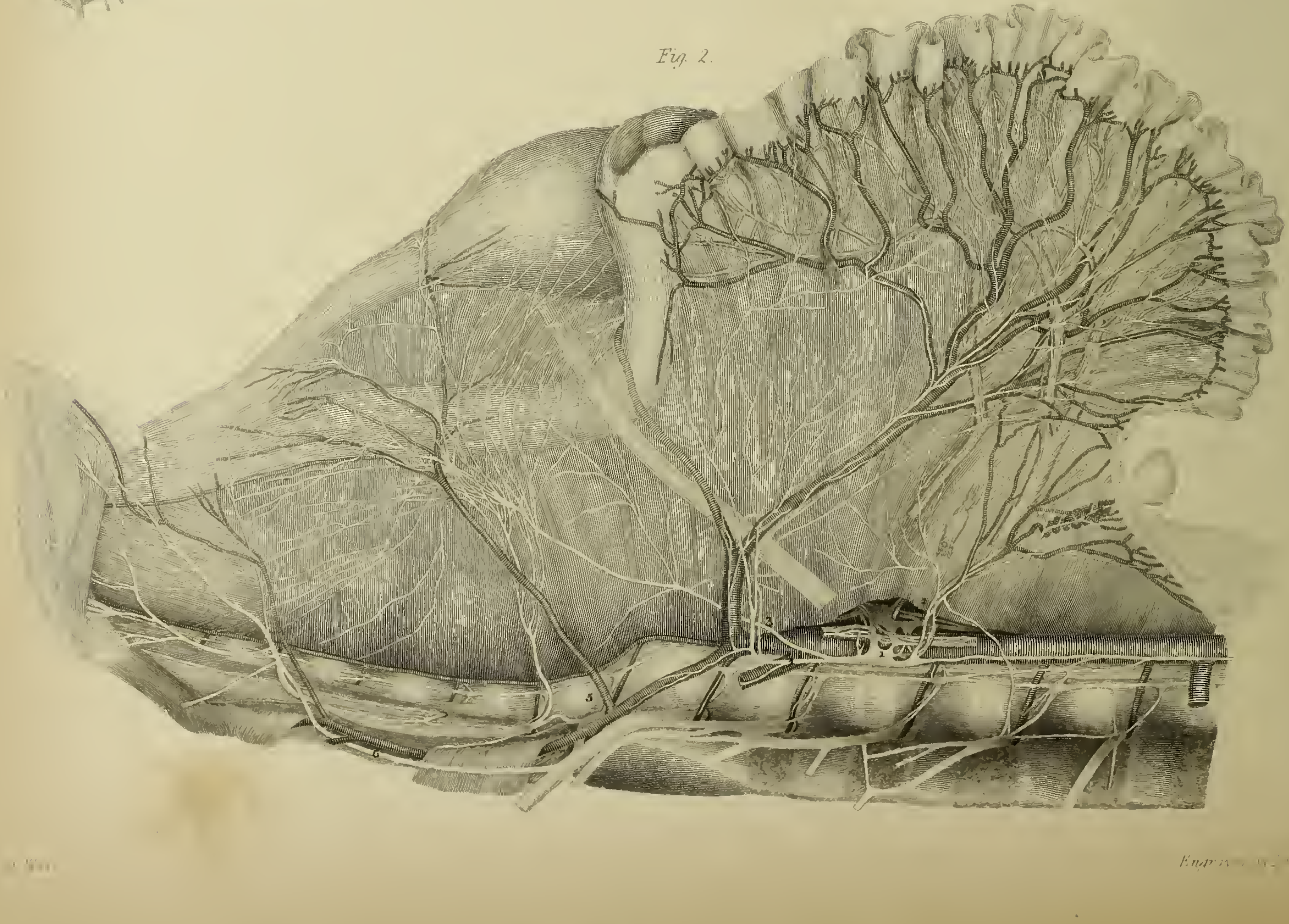


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PLATE XXXIV.

FIGURE I.

THE HYPOGASTRIC PLEXUS OF THE MALE CALF.

(BOS TAURUS.)

1. Prolongation of the sympathetic nerve.

2. Hypogastric plexus passing downwards to communicate with branches of sacral nerves, to be distributed on the bladder and parts connected with the neck of this, and on the rectum.

3. Continuation of the prolongation to be connected with that of the left side on the caudal artery in the single ganglion.

4. Anterior caudal nerve.

5. Posterior caudal nerve.

This figure is placed here that the plexus of a male animal may be contrasted with that of a female, for showing that in both it exists very much for supplying the bladder and rectum, and, although it is connected with the reproductive organs of both, it takes a subordinate part in their functions according to the statement in page 132.

FIGURE II.

THE HYPOGASTRIC PLEXUS OF THE SOW.

(SUS SCROFA.)

1. Ganglion of the aortic plexus.

2. Internal spermatic nerve, passing with the spermatic artery in the broad ligament to the ovary, the fallopian tube, the round ligament, and superior part of the uterus.

3. Hypogastric plexus; it gives off the uterine nerve and a smaller branch; it passes down and is joined by branches derived from a large branch of the second sacral nerve, which has been joined by a branch of the first; it then gives branches to pass with the inferior uterine artery to the neck of the uterus, and communicate with the uterine nerves, whilst the rest terminate on the bladder, vagina, and rectum.

4. Uterine nerve; at page 118 it is called the inferior spermatic plexus; this ramifies with branches of the large uterine artery and veins in the broad ligament, like the mesenteric nerves and vessels, to be distributed on the long horn of the uterus; a smaller branch is also ramified in the broad ligament. The ramifications of the uterine nerve near the uterus could not be distinctly seen without a magnifying-glass, and, as this engraving is about a fifth part of the dimensions of the drawing, they are of necessity made larger than they exist in nature.

5. First sacral nerve.

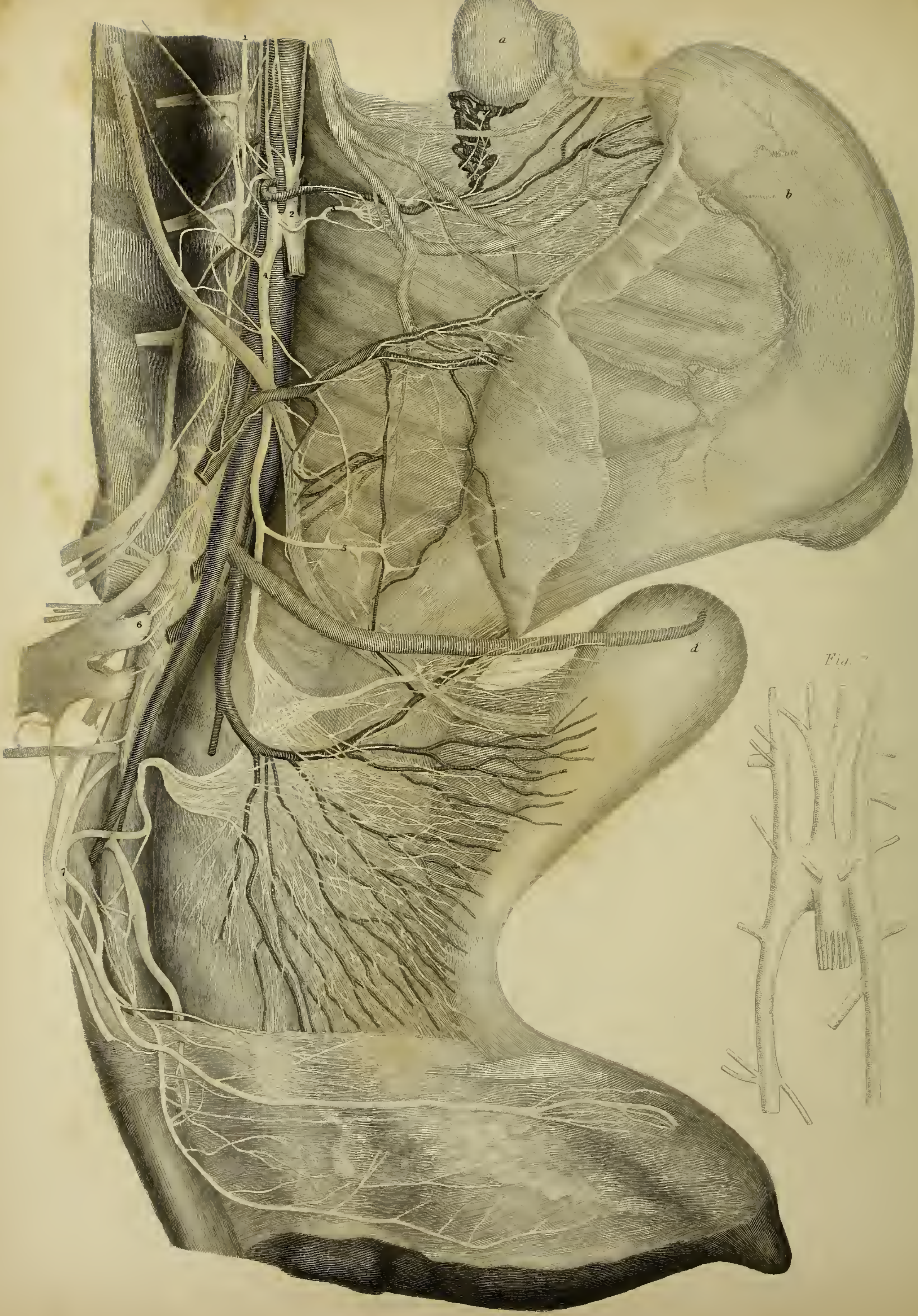
6. Internal pudendal nerve.

FIGURE III.

THE SAME.

It shows the ganglion of the aortic plexus, and the hypogastric plexus of each side of the natural size.

Fig. 1.



Drawn by West

Engraved by Finden

London, Published by Longman & Co. [illegible]

PLATE XXXV.

FIGURE I.

THE HYPOGASTRIC PLEXUS OF THE ASS.

(EQUUS ASINUS.)

a. Ovary.

b. Right horn of the uterus.

c. Ureter.

d. Bladder.

1. Prolongation of the sympathetic nerve.

2. Ganglion of the aortic plexus.

3. Internal spermatic plexus; it accompanies the spermatic artery and gives branches to the ovary, the fallopian tubes, and the round ligament; a branch was traced a considerable way down on the lining membrane of the uterus on the left side.

4. Hypogastric plexus; it gives off the uterine nerves, and communicates with branches of the fourth and fifth sacral nerves, and in another preparation with the sixth; it then sends branches to the remains of the umbilical artery, the lower part of the uterus and vagina, and communicates with the uterine chord, and then terminates on the vagina, bladder, urethra, and rectum. After its combination with the sacral nerves, it was intermixed with the same dense membrane described at page 118.

5. Uterine chord; it receives a branch from the hypogastric plexus, and is joined by another, and then by a third from the point of union of the hypogastric plexus with branches of the fourth and fifth sacral nerves; it sends filaments in the broad ligament to accompany the branches of the uterine arteries and veins to the uterus.

6. First sacral nerve.

7. Internal pudendal nerve.

FIGURE II.

THE SAME.

It shows the full size of the ganglion of the aortic plexus, and the hypogastric of each side; and the hypogastric plexus larger on the right side than the left.

At page 131 the uses of different nerves for particular portions of several organs have been pointed out, as well as the combination in function of various parts through the hypogastric plexuses. The internal spermatic nerves are principally concerned in reproduction, and excite the primary changes in the ovary and uterus required for the evolution of the ova; the branches arising from the hypogastric plexus, which approach the spermatic in function, are next influenced; then the branches proceeding from the hypogastric plexus and sacral nerves, which by this conjunction have modified sensitive and motive qualities; whilst more exteriorly the common sensitive and motive nerves alone are necessary.

The spermatic nerves do no more than excite, and then maintain a proper action in the ovary and its blood-vessels, for the growth of the ova, as the fecundation of these, in many instances, takes place after their exclusion.

The distribution of branches of the sympathetic nerve only to the ovary and upper part of the uterus of an uniparous animal, and to nearly the whole of the long horn of a multiparous one, makes it probable that these are necessary for the growth of this organ and the embryo, and that the conjoined hypogastric and sacral nerves more especially determine the first changes required for parturition. Whether the animal be uniparous or multiparous, or the neck of the uterus be placed high up or low down, the conjoined hypogastric and sacral nerves are directed most to the lower part of the uterus and the vagina, and render these parts more irritable than if they had been furnished by the sympathetic only, so that near the maturity of the embryo the extension and pressure gradually excite the more sentient nerves; from these the irritation is conveyed to the other uterine nerves, and produces the tetanic expulsive action: the disposition of the nerves of a multiparous animal leads to the conclusion that the parturient action commences from below in the part containing the lowest fœtus.

The passive state of the uterus does not require so large a proportion of nerves as the bladder, vagina, and rectum, which must be always ready for action. The living embryo has the power of exciting both the nerves and blood-vessels, and maintaining a gentle and equable action commensurate with its nourishment and the required functions of the enlarging uterus; after birth the nerves and blood-vessels return to their ordinary quiescent condition, the stimulus no longer existing.

In some animals the fœtus does not permit long the placental circulation, but requires changes consistent with the maturity of several organs. The particular arrangement of the nerves and blood-vessels, by allowing a slower or more free circulation in the uterus and fœtus, has some share in determining the period of birth; in the multiparous animal it permits a more rapid growth of the fœtuses, as each, with the portion of uterus containing it, is supplied with blood equally and freely throughout; in the uniparous the supply of blood is more limited, the arteries and nerves becoming more influenced in succession according to the required progress of enlargement of the uterus and fœtus.

The contents of an egg, kept in a sufficient heat for three weeks, produce a perfect animal, with a nervous system developed for performing all the leading functions with circulatory, respiratory, nutritive, and locomotive organs. In some viviparous animals a long delay in the uterus and a constant supply of blood are necessary for the same purpose; in many produced in a more immature condition a shorter period suffices, the rest of the growth being performed through the digestive organs. Such facts show that the uterus performs only a subsidiary purpose in reproduction.

The several classes of animals having been separately considered, it may be useful in a concise summary, to combine in separate points the same facts relating to each of them.

The brain is more or less spherical or lobulated in all animals; in man, at the upper part of its hemispheres, there is an extensive fissure, and one more or less deep in many of mammalia; but in some of these and the other classes there is a very little if any, separation. Convolutions answer a particular and not a general purpose; they are very deep in man, and some of mammalia; but in others and the several inferior classes they hardly exist. The great commissure is very extensive in man and such of mammalia as have the hemispheres high and large; it faintly exists in others, in which the lobes only just inclose the lateral ventricles; it is not present in the three lower classes. Ventricles vary in all the classes; the lateral has a posterior horn in simiæ proportioned to the posterior lobe, so that in some it is a mere chink; in birds it extends more posteriorly, at which part its parietes are very thin; it is placed anteriorly in amphibia and fishes. The third ventricle lies between the thalami in mammalia and birds; in birds it extends into the optic lobes; in amphibia and fishes it is continued from the same surface with the lateral. The fourth ventricle exists in all; and in birds, amphibia, and fishes, extends into the optic lobes and cerebellum. The transparent septum exists in mammalia only; in birds, the striated septum supplies the place of it and the great commissure. The former exists in mammalia only; in birds, the floor of the lateral ventricle supplies its place. The great hippocampus exists in mammalia but not in the other classes. The striated body exists in the three superior classes; in mammalia it is similar to that in man, but very different in birds and amphibia The thalamus exists in the three superior classes, but is very small in amphibia. The soft commissure depends upon the presence of each thalamus; it is very tough in the turtle. The anterior commissure exists in the four, the posterior in the three superior classes. There is a pineal gland in mammalia and the turtle. The quadrigeminal bodies are distinct in mammalia, but vary, the nates being either larger or smaller than the testes: they are solid at birth; in birds they are flattened and large and have no distinction like that of the nates and testes, and contain a ventricle in each communicating with the third; they also exist as hollow bodies without any anterior or posterior separation in amphibia and fishes. The base of the brain is divided into lobes in man and simiæ, but in most others there is very little, if any, distinction; the pituitary gland exists in the four superior classes. Two distinct mamillary eminences exist in man, but they are very generally conjoined in mammalia; they do not exist in amphibia, they are however not only present but separate in fishes. The cerebellum exists in the four superior classes; in the invertebrated its presence is doubtful; it has large lateral lobes compared with the middle, and is large in proportion to the size of the body in man and simiæ; the lateral lobes compared with the middle ones are smaller in mammalia generally; it is convoluted throughout; in birds, it consists principally of a middle lobe, to which is attached on each side a small one like the lobule appended to the lateral lobe of the monkey and other animals; it is convoluted, and has a ventricle; in some of the amphibia, as the turtle, it is hollow, in several it is a mere rudiment. In the cod, it has a small ventricle, and consists principally of a middle lobe; in the skate it has a ventricle, it has also lateral lobes which are somewhat convoluted. The annular tubercle is largest in man, it is proportioned to the size of the crura of the cerebellum; it exists in mammalia, the trapezoid body is a resemblance of the posterior part of it; it is not distinct in birds, and does not exist in amphibia and fishes; it is proportioned to the size of the crura of the cerebellum. The oblong medulla is larger in mammalia in proportion to the size of the brain than in man, but particularly in the other classes ; small olivary bodies exist in the monkey ; the other eminences in the four superior classes are more or less indistinct.

The olfactory nerve, except in animals not having a nose, exists in the four superior classes ; it arises from the anterior lobe of the brain ; it varies and is of small size in man and simiæ, and very large in mammalia generally ; it varies in the form or absence of the ganglion in birds and amphibia, and the shape of the ganglion in fishes. The optic nerve exists in the four superior classes and many of the invertebrated ; in the three superior the tract is connected with the thalamus, and in the four with the optic lobe, and in some degree with the crus of the brain and the mamillary eminence or the part contiguous to this, and in mammalia with the geniculate body. The commissure of the two tracts varies ; it is large in man, less in mammalia, and still less in amphibia and fishes ; there is an interchange of fibres from each tract in it, but in some fishes there is a complete decussation of the two nerves. The third nerve arises in mammalia from the inner side of the crus of the brain ; in birds, amphibia, and fishes, from the oblong medulla, near the same place ; in all, it supplies similar muscles and contributes to the ciliary nerves, which are not so numerous as in man, and do not always proceed from a ganglion. The fourth arises behind the optic lobes in the four superior classes, and has the same destination in the superior oblique muscle ; in man it communicates with the lachrymal nerve. The fifth arises principally from the oblong medulla in the four superior classes, and in man and mammalia partly from the annular tubercle ; all the cerebral nerves, except the optic, are similar to it in invertebrated animals. The smaller and larger portion which are present in man and mammalia are not so distinct in the other classes. Some interchange similar to that in the Gasserian ganglion exists in all. There are always three trunks, but in some fishes more. The first trunk supplies the parts about the orbit and fore-head, the superior nasal extends through the nose to the skin near the anterior part of this organ in mammalia, and in birds and amphibia to the anterior portion of the palate and beak. The second trunk gives branches to the temple and horn, the inferior part of the orbit, the nose, the palate and teeth ; its principal portion terminates in the upper lip or the part answering to this, and is usually larger when the nerves of the toes are less. The third trunk supplies the skin on the anterior surface of the external ear, and part of the temple and face in mammalia ; the inferior dental supplies the teeth and bone of the lower jaw, and the part corresponding with the lower lip in the four superior classes ; the mylo-hyoideal nerve in some of mammalia sends a branch into the face to communicate with the hard portion ; it is very small in the goose and very large in the pelican : in the turtle there are two branches, and in the snake three; the other branches of this trunk vary, according to the presence or absence of muscles and other parts, or the necessity for modified functions. The gustatory, as a large nerve, exists only in mammalia, a branch analogous to one given by it to the lining membrane of the mouth may be resembled by those of the inferior dental in the other classes; it is presumed that this large branch in experiments may be sometimes mistaken for the glosso-pharyngeal. In some fishes the fifth gives off the auditory nerve, and furnishes a large posterior branch for communicating with the spinal nerves. The sixth exists in the four superior classes with very little difference except in size, when it supplies supernumerary muscles which are not found in man; it arises in all from the oblong medulla, the only variation consisting in the more or less marked appearance of the pyramidal and trapezoid bodies, and the posterior part of the annular tubercle with which in man it is sometimes connected. It communicates with the sympathetic in man and the monkey in a similar manner, but in other animals rather differently. The auditory is present in the four superior classes; it arises in all from the oblong medulla, and in mammalia a portion of it is traced to the fourth ventricle; in some fishes it is a branch of the fifth, it may therefore be presumed that much difference between it and the fifth does not generally exist. Its distribution varies in some degree according to the shape of the labyrinth. The hard portion exists in the three superior classes; it arises from the oblong medulla in man, it has some connexion with the posterior part of the annular tubercle, and proceeds from the trapezoid body in mammalia. In birds and amphibia its size is less than in mammalia, as the muscles of the face are absent. The glosso-pharyngeal nerve exists in the four superior classes; its origin from the side of the oblong medulla is more or less defined by the pyramidal bodies. In mammalia, besides the other distributions, it sends filaments into the tympanum; it supplies the back of the tongue and the anterior part of the epiglottis; in birds it is larger in proportion to the par vagum than in any of the other classes, and communicates more with the sympathetic; it gives the branch to the glottis, which in mammalia is furnished by the par vagum, and supplies the tongue as far as the tip; in amphibia it is in some respects the same as in birds; in the snake it supplies the glottis, whilst the par vagum does that of the turtle as in mammalia; in fishes, its origin is connected with that of the par vagum, and it supplies the first gill and part of the membrane of the throat; in three classes it it connected with the organ of hearing, but not in the turtle, the par vagum rather supplies its place. The pharyngeal plexus is most complicated in man, next in mammalia; in some of the birds and amphibia, as the pelican, crane, and snake, the combination of nerves is much greater than in the goose and turtle; but in fishes the pharynx is supplied by branches of the par vagum along with the stomach. The par vagum exists in the four superior classes, and is not very different; it, as well as some of its branches is larger, according to the extent of the parts to be supplied; it gives off one or more lateral or dorsal branches in fishes; in mammalia the external and superior laryngeal and recurrent nerves are similar to those in man, but their branches are rather more combined before their termination; in the jaguar, the superior laryngeal as well as a minute branch of the external laryngeal pass through separate foramina in the thyroid cartilage; the recurrent nerves differ in birds and amphibia from those of mammalia in supplying the œsophagus in a greater degree than the larynx. In fishes a recurrent branch also exists, which winds round one of the branchial arteries to supply a muscle connected with the motion of the gills; the pulmonary branches are similar in the four superior classes, but are destined for the gills in fishes instead of the lungs in others. The cardiac plexus is formed of the sympathetic, par vagum, and recurrent in mammalia: it is more complicated in man; it is similar in birds; in amphibia it is formed more of branches of the par vagum; in fishes, its state has not been determined. The par vagum supplies the stomach in the four superior classes, the branch connected with the cœliac plexus for keeping all the small intestines and the beginning of the colon under the influence of the brain exists throughout mammalia; a communication between a branch of the par vagum and the cœliac and splanchnic nerves exists in birds; in the snake, communications also exist; in fishes there are also some. The ninth exists in the three superior classes, it arises from the oblong medulla, it supplies the muscles of the tongue and others connected with the hyoid bone and thyroid cartilage. In some birds, as the goose and turtle, it resembles very much that in mammalia, but in others, as the pelican, crane, and snake, the glosso-pharyngeal, par vagum, and ninth are so conjoined, that it is very difficult to determine the destination of each. The accessary nerve exists in man and mammalia; in birds it is not present, unless the lengthened origin of the par vagum may be considered as a part of it; in some of amphibia it may be seen as in the turtle, but not in fishes.

The spinal marrow is nearly the same in the four superior classes; in the invertebrated there is a chord or ring in the place of it, analogous to its nerves and ganglia; it varies either in breadth or length, according to the required motion of the spine, and the number and size of the nerves; it may be short and broad, or long and narrow, with enlargements in places from which larger nerves are to proceed; it may form a longer or shorter cauda equina. In birds it appears knotted, and has its dorsal part closely surrounded by bone, and has a lumbar ventricle ; it reaches to the tail in birds, and generally in amphibia and fishes.

The number of spinal nerves varies in each class. There is an anterior and posterior origin of nerves from each portion of it in the four superior classes, a ganglion is generally formed by the posterior, this however may not only vary in structure, in being either thready or fleshy, but in the disposition of the nerves attached to it, as in the cod. Ganglia are both fleshy and thready in mammalia, fleshy in birds and amphibia, but much more indistinct in fishes ; in the skate a very small ganglion is attached to each posterior fibril, and in the cod most of the anterior and posterior bundles, after leaving the spinal marrow, are not only arranged differently, but the ganglionic structure is very equivocal. In the ventral surface of the chord of the lobster there are ganglia, but not in the ring of the crab, nor in the nerves proceeding from it. In almost the whole of mammalia, the number of cervical nerves is the same as in man ; in birds it is very various ; also in amphibia ; in some there is very little distinction as well as in fishes, the nerves of the toes covered by a hoof are smaller in proportion to those covered only by cuticle. The phrenic nerve exists in mammalia only. In animals having upper extremities, the lower cervical and first dorsal nerves generally form an axillary plexus from which these parts are supplied; it is composed of more or fewer spinal nerves, and generally sends off similar trunks, which are larger or smaller, or differently arranged, according to the size, and the required direction of the muscles. In mammalia, birds, and some of amphibia, as the turtle, the axillary plexus is produced by the lower cervical and first dorsal nerves ; in the frog there is one large nerve instead of the plexus ; in the snake it is absent ; in fishes there is some resemblance of it, and particularly in the skate. It divides into similar nerves in mammalia and birds ; in the turtle they resemble most the median, spiral, and circumflex ; in fishes they hardly bear any comparison. In mammalia the number of dorsal nerves is seldom fewer, but often greater than in man. In birds it is generally fewer, as well as in amphibia ; but in snakes and fishes a distinction cannot be made. Each nerve varies according to the extent of parts supplied. The lumbar, sacral, and caudal nerves of mammalia, are similar to those in man, the number of lumbar is generally greater, that of sacral less ; from some of these a plexus is formed, which sends off the anterior crural, obturator, sciatic, and several smaller nerves. Similar nerves are given off in birds and amphibia, but vary to suit the difference in the form and size of the muscles, and the required sensibility of the integuments. In mammalia the tail is supplied by an anterior and posterior caudal nerve on each side ; in birds, amphibia, and fishes, by numerous small nerves issuing from the spinal marrow to the end of the tail.

The sympathetic nerve is distinct in the four superior classes; it varies in having a more or less close, or open texture. In mammalia there is a superior cervical ganglion, it is very small in birds, very distinct in the snake, but not in the turtle and fishes; in man it sends branches to communicate with the sixth, the Vidian nerve, and the Gasserian ganglion; in the monkey it is the same, but in mammalia generally there is some variation; in birds and amphibia it communicates with the ninth, the par vagum, the glosso-pharyngeal, the hard portion and fifth; two of the branches passing upwards may be compared with the Vidian; in fishes there is a communication with the par vagum and fifth, and as cervical ganglia do not exist, the first may be compared with the thoracic sending off the splanchnic nerves. In mammalia it communicates with the nerves of the pharynx, and supplies the branches of the external carotid, and the salivary glands; it also usually communicates with the glosso-pharyngeal, par vagum, ninth, sometimes with the accessary, suboccipital, and one or two of the superior cervical nerves. The prolongation descends to the first thoracic ganglion, sometimes becoming connected in its course with one or more ganglia in the neck; it is either separate from or adhering to the par vagum; in birds there is a very slender branch sent with the carotid artery; in the pelican that of each side becomes joined, and then accompanies the united trunks of the carotid, and divides again to communicate with the ganglion of the last cervical nerve but one of each side; in the turtle there is a strong prolongation, but in some species it adheres so closely as to appear like a part of the par vagum. In man, branches from the cervical ganglia and prolongation communicate with the cervical nerves; but another communication is formed by branches sent up with the vertebral artery; in mammalia and birds, this is the chief mode of connexion with the cervical nerves; in the turtle, branches are sent upwards, but not in a distinct spinal canal; in the snake, the superior cervical ganglion sends a branch to the par vagum, which may be compared with the prolongation, but it cannot be separated again; the principal way of communication is by a branch sent downwards in an imperfect canal close to the spine; in fishes it does not exist. The first thoracic ganglion exists in the four superior classes; it is generally very large in mammalia, it is small in birds, in the turtle it is membranous, but in the frog and snake there is not a distinct ganglion; in fishes it is large and appears as the most superior ganglion. From the cervical and first thoracic ganglia in man and some species of mammalia, and in others also from succeeding thoracic ganglia, as well as from the par vagum, the cardiac nerves are given off; in birds these proceed from the first thoracic ganglia and the par vagum; in amphibia they proceed most from the par vagum; in fishes they are not ascertained. In mammalia the prolongation is continued down the thorax, either flat like tape with small ganglia imbedded in it, or in a narrower and thicker form with more distinct ganglia, for communicating with the spinal nerves; in birds the thoracic prolongation is double to some distance; in the turtle it is also double, but the ganglia are very small and connected with the spinal ganglia as in birds; in the snake it is a fine thread communicating with each spinal nerve, but not forming ganglia; in the frog there are not any ganglia, but at the connexion with each spinal nerve, there is a cluster of pearly vesicles containing cretaceous matter; in fishes there are small ganglia at the point of connexion with the spinal nerves. In man, from the thoracic portion the splanchnic nerve is given off; in mammalia this is in some instances similar to that in man, but generally it remains connected with the prolongation throughout the thorax; a smaller splanchnic nerve is also given off; but it is not more worthy of distinction than many other branches; in birds there are two principal splanchnic nerves, the upper accompanying the cœliac artery, the lower communicating with the renal capsule, and accompanying the superior mesenteric artery; the semilunar ganglion is very small; in the turtle there is the same disposition, but instead of a semilunar ganglion, a plexus is present; in the snake this plexus is more extended, and has still less of the form of the ganglion; in fishes there is a considerable fleshy ganglion; whether there be a semilunar ganglion or a plexus, there is a similar distribution to the several organs. The lumbar and sacral portions in mammalia resemble those in man; the ganglia in birds, amphibia, and fishes, are much smaller and more indistinct. The spermatic nerves in mammalia are generally less complicated than in man; in birds they proceed from the lower splanchnic nerve, at its connexion with the renal capsule; in amphibia numerous branches are given off to the ovary and the long oviducts; in fishes they proceed from the sympathetic, at the lower part of the abdomen. The renal nerves in mammalia are generally rather more simple than those in man; in the other classes they have a more extended origin. The termination of the sympathetic in the single ganglion is continued on the caudal artery into the tail. In mammalia the hypogastric plexus, is similar to that in man for supplying the reproductive and urinary organs, and the lowest portion of the intestines in the male and female after a conjunction with some of the sacral nerves; its branches are, therefore, differently disposed according to the sex; in birds it is resembled by the long nerves, formed by the spinal and sympathetic for the parts about the cloaca and tail; in amphibia it is still more simple. Branches of nerves do not entirely surround hollow viscera; except blood-vessels, the œsophagus, and other ducts, whose capacity is determined; for if they were extended beyond a certain point, their functions would be either impeded, or they would be subjected to a degree of irritation incompatible with the continuance of life.

Although in the preceding pages, the nerves have been considered from their origins to their terminations, it may be useful to notice particularly the faculties of the several organs composing the body, and the relation they bear to the centres, and then briefly revert to the general leading characters of the nervous system.

Just physiological inferences cannot be drawn from the examination of any single creature. Comparative anatomy shows that in the higher classes the functions of many organs are not very different from those of the lower, and thus determines how much of the structure is really necessary for conferring faculties proper to both, and how much ministers to a more complicated condition.

The several tissues and organs may be noticed separately for convenience, but their physiology cannot be understood unless they are considered together both in the quiescent and active states of the living body. Every animal must be contemplated in its perfect condition, its various parts acting and being acted upon either directly or indirectly by and through the entire nervous system, and although some of the organs have a greater influence than others, yet all of them make their respective impressions on the centres and instinctive essence, and give to them that full power which is consistent with the attributes of a perfect creature, for until it has been impressed by all the organs, it remains defective in several impulses, which are necessary for leading it to fulfil certain conditions belonging to its station, and which it is incapable of becoming acquainted with in any other manner.

SMELLING depends upon the olfactory nerve arising from the brain and the fifth arising from the oblong medulla. The organ may be small or very capacious; branches analogous to those of the fifth may produce a rudimental sense in some invertebrated animals.

SEEING depends upon the optic nerve arising from the brain, and the third, fourth, fifth, and sixth arising in the track of the oblong medulla. The organ varies in size, but not like the nose; the ciliary nerves are not in proportion to the size of the organ, but to the required powers of vision. Although there is an optic nerve arising from the brain in some of the invertebrated animals, yet in many instances the organ is rudimental and the nerve analogous to the ciliary.

HEARING depends upon the auditory nerve, the fifth, the hard portion and the glossopharyngeal, which arise from the oblong medulla. The auricle and tympanum vary in each class, and in different kinds of the same in a slighter degree. The labyrinth is similar in mammalia except slight variations in the windings of the cochlea ; it is further modified in birds, and still more in amphibia and fishes. In fishes the auditory, or fifth, and glosso-pharyngeal are more conjoined for supplying the labyrinth ; instead of the fifth and glosso-pharyngeal being confined to the tympanum and its appendages. In invertebrated animals the rudimental form of nerves may approach that of fishes and resemble that for the tympanum only in the higher classes.

TASTING depends upon the fifth, glosso-pharyngeal, and ninth, which arise from the oblong medulla. The organs concerned in its production are very extensive in many of mammalia. The nerves are proportioned to the organ and the oblong medulla, and not to the brain or cerebellum. Although branches of the fifth supply the mouth in the other classes, the glosso-pharyngeal appears to be the most important. In the invertebrated any sense of taste may have a rudimental condition approaching that in the three preceding classes.

SENSATION depends upon the fifth and spinal nerves arising from the oblong and spinal medulla; the ganglia attached to them are variously constructed in different animals. The brain may be large or very small; the cerebellum may be large or rudimental. In invertebrated animals the nerves may proceed from the subœsophageal ganglion and the prolongation of this in a chord or ring, or from ganglia having the least possible resemblance to a brain. It is probably modified by all these changes as well as by the extent of the convolutions of the brain. Under this head the following parts may be included : skin, teeth, bone, ligament, and those giving origin to horn, hair, and nails.

VOLUNTARY MOTION is under the third, fourth, fifth, sixth, hard portion, ninth, accessary, and spinal nerves, and the oblong and spinal medulla. In invertebrated animals the nerves may proceed from the subœsophageal ganglion, or from a prolongation of this in a chord or ring, or from ganglia having the least possible appearance of a brain ; in many instances there is no difference in the dorsal and ventral surfaces of the chord or ring, and in the highest of this class there is not the same distinction as in the vertebrated.

INVOLUNTARY MOTION is under the sympathetic, or such of the common motive as have their powers directed by the action of moving parts placed in contact or connexion with them ; it is therefore principally under the influence of the oblong and spinal medulla.

CIRCULATION. The nerves promoting it proceed from the sympathetic and par vagum, so that it is principally under the influence of the oblong and spinal medulla.

In mammalia and birds which have hot blood and a completely double circulation there is a large brain. In animals with cold blood, as amphibia which have not a completely double circulation, and fishes which have one still more simple, the brain is small and the cerebellum may be a mere rudiment. In invertebrated animals there may be a different form of the circulatory organs when the nervous system is similar. Blood is required for supporting the functions of the nervous system ; it is varied for harmonising with the condition of different animals ; it is rendered efficient according to the supply of oxygen : it combines with the nervous element, and may therefore be perceptive ; it does not combine with the instinctive essence, and therefore is not sentient.

ARTERIES AND VEINS depend upon the sympathetic and par vagum, and others in their respective regions ; they therefore are connected principally with the oblong and spinal medulla.

RESPIRATION. The larynx, trachea, and lungs depend principally on the par vagum, they have however some smaller contributions from the sympathetic ; the muscles moving the chest depend on the spinal and sympathetic nerves, the whole are, therefore, under the influence of the oblong and spinal medulla. In mammalia there are lungs with small delicate cells, and in birds with larger and more fleshy cells, and both have hot blood, and there is a large brain and cerebellum. In amphibia, whose lungs have a more rudimental cellular structure, and in fishes which have gills, and in both cold blood, the brain is small and in many instances of amphibia the cerebellum is a mere rudiment. It does not appear that the form of the nervous system determines the respiratory functions in invertebrated animals, as the same does not correspond with the presence of many vesicles or a single one, or of air tubes or bronchiæ.

MOUTH AND SALIVARY GLANDS. The nerves proceed from the fifth and hard portion of the seventh, in mammalia, and more particularly from the fifth in the three lower classes, and in all from the oblong medulla. In invertebrated animals it is probable they proceed from nerves analogous to the fifth.

ŒSOPHAGUS AND STOMACH. The nerves proceed principally from the par vagum arising from the oblong medulla ; there are besides filaments derived from the sympathetic.

INTESTINES. The nerves of the small and superior part of the large intestines proceed principally from the sympathetic, but some also from the par vagum ; the inferior part of the large intestines is supplied by the sympathetic, and the rectum by the sympathetic and sacral nerves conjoined, and the sphincter and skin by the sacral only. They are, therefore, in some degree under the influence of the oblong and spinal medulla. In birds, amphibia, and fishes, the disposition of the nerves is somewhat different, probably to correspond with the modification of structure, but the intention is the same. In the invertebrated, the nerves approach nearer to those of amphibia than of the other classes, and are generally proper for actuating the viscera, and therefore less change appears to be necessary for these purposes; but when any extraordinary deviation is required for modifying them, the alteration is made by appending one or more ganglia to particular nerves; the structure of the organ itself, however, takes some share in producing the varied function.

LIVER, SPLEEN, PANCREAS. The nerves are derived from the sympathetic, and from the par vagum, arising from the oblong medulla.

EXHALANTS AND ABSORBENTS. The nerves proceed principally from the sympathetic, par vagum, fifth, and spinal nerves, so that they are particularly under the influence of the oblong and spinal medulla.

CELLULAR MEMBRANE. It is probable that the cellular tissue of the brain, and of that of the body generally, is supplied by the fifth and the spinal and sympathetic nerves, and is therefore under the influence of the oblong and spinal medulla; part of it, entering particular organs, may also partake of the nerves supplying these.

KIDNEY. The nerves are derived from the sympathetic. The ureter is supplied by the sympathetic, and at its lower part also by the conjoined hypogastric and sacral nerves.

BLADDER. Its nerves proceed from the hypogastric plexus and sacral nerves conjoined, so that it is under the influence of the spinal medulla, and probably in a slight degree under the oblong also.

OVARY AND TESTIS. Their nerves are derived from the sympathetic only.

UTERUS AND VAS DEFERENS. These and their continuations are supplied by the sympathetic, and the hypogastric and sacral nerves conjoined, and are under the influence of the oblong and spinal medulla.

MAMMA is under the influence of the spinal nerves and spinal marrow, except as far as they communicate with the sympathetic.

SPINAL MARROW. It gives origin to the sensitive and motive nerves of the trunk of the body; its functions are very limited, independently of the brain. In invertebrated animals, a long chord or ring analogous to the ganglia and nerves of the spinal marrow and sympathetic exists.

OBLONG MEDULLA. It is required for all the vital functions, and for sensation and motion; the brain, cerebellum, and spinal marrow are not absolutely necessary, they nevertheless, according to their development, extend its powers. Only the two organs of smelling and seeing receive nerves directly from the brain, and they require others from the oblong medulla for the completion of their functions. All the other organs, not supplied by nerves from the oblong and spinal medulla, are indirectly connected with those parts through the sympathetic nerve. If the brain and cerebellum do not immediately promote the functions of the several organs, they complete the concatenation of faculties required in the more perfect creatures.

BRAIN. Only a very small brain in proportion to the size of the body exists in some animals, and is principally for the senses of smelling and seeing, and for ministering to the intellect, and for this purpose it is fashioned with modifications of structure. According to the increase of the intellectual faculties, the hemispheres become larger in proportion to the oblong medulla. In invertebrated animals, its most complex state is inferior to that of fishes, and in many instances is so rudimental as scarcely to deserve the name.

CEREBELLUM. Its condition may be a mere rudiment in some complicated animals, and increasing from this to its large size in man. The vital and instinctive functions, and those of sensation and voluntary motion, do not depend upon it.

SYMPATHETIC NERVE. It exists more or less distinctly, but with modifications, in the four superior classes; in the invertebrated, the functions usually performed by it are more conjoined with the rest of the nervous system. It is related to the spinal and oblong medulla, through the nerves arising from these parts.

SOUL AND MIND. These, with their powers of reflection and other attributes, belong entirely to man.

INSTINCTIVE ESSENCE. The glimmering emanating from the instinctive essence in animals, and constituting the intellect, cannot be compared with the mind. Its faculties are greater or less according to the structure, and not according to the size of the centres through which it acts, and the condition of the various organs of the body which impress it. Its power is prevented from being manifested by narcotics and various agents affecting the material organs. According to the impressions it has received are its actions modified, and consequently the habits formed, so that the animal at length acquires its full degree of intelligence and subtlety, and is enabled to fulfil the various actions necessary for insuring its own existence, and the perpetuation of its species. The soul of man has conjoined with it the power of exerting vital functions, similar to those conferred by the instinctive essence in animals. The instinctive essence is combined with the centres through the nervous element.

NERVOUS ELEMENT. The nervous element is active before the appearance of the grey and white matter of the brain and spinal marrow, and the ganglia and nerves; these are in due time formed as a fit receptacle for it, and a proper medium for spreading its influence over the body. Perceptibility, as well as the power of exciting anormal motive actions in muscles, is retained in portions of the centres and nerves; also of keeping up the action of the heart by artificial respiration, as long as the nervous element is present; but the control over the muscles is removed, as well as sensation and respiration, along with the instinctive essence.

GREY AND WHITE MATTER. Neither the grey nor white matter can be discovered in every animal; but as they exist so extensively, they may be considered as one of the chief means of combination with the nervous element, and thus as a principle.

SHAPES OF THE GREY AND WHITE MATTER. The grey and white matter require to be placed in a particular order, shape, or form, and to be more or less intermixed with each other; and according to this elaboration are their powers varied and modified, either for general or particular centres. The more extended portions of the brain for promoting the intellectual faculties, and the more particular ones as centres for the origins of the nerves, are formed on an appropriate plan, and have their prescribed situation, but vary in some respects in different animals. The instinctive essence manifests its power differently, according to the condition of the structures through which it acts. The more elaborate the ranges of the fibres of the centres, and the construction of the several organs of the body through which the mind and instinctive essence are approached, the more exalted is the manner in which perceptions and the commands of the will are executed; so that, on account of the great development of the brain in man, the mind receives and imparts impressions, which the instinctive essence cannot. The shapes may, therefore, be reckoned as a principle, as the modifications of the same determine the extent of many faculties.

NERVES. A simple nerve prevails more extensively than any other structure, and therefore might be classed before the centres. Nerves of the special senses, the common sensitive and motive, and those of the vital organs, have different functions according to their origin, structure, and termination, and according to simple connexions, modifications in ganglia, or more or less intricate plexuses. These arrangements are conducted on a principle, inasmuch as there are appropriate textures and forms for supplying many organs, and modifications for corresponding ones in various animals. They are further modified by the difference in the quantity and quality of the cineritious and medullary matter, and the proportion of neurilema.

Organs of the body. The situation and structure of the several organs, and the variations of corresponding ones, modify not only the functions of the nerves, but those of the centres and instinctive essence; according to their development they impress the centres, and thus confer additional faculties; the arrangment and ramification of the blood-vessels, and their mode of connexion with the nerves, the quality of the blood, and the degree of its changes by respiration, also exert a considerable influence. These have been determined on a principle, according to the situation each animal was destined to occupy, and the necessities to which it must be subjected.

Precedence of principles. If any of the preceding properties, except the instinctive essence and nervous element, be adopted as the leading character of the whole, it may suffice in a few instances to a limited extent, but it will not generally. If one be preferred without sufficient reason, and the rest be made subservient to it by distorting their natural characters, a specious system may be constructed, but it will lead only to confusion.

Without the extreme care and skill bestowed on the drawings by Mr. West, and on the engravings by Mr. Finden, the utility of the work must have been very much diminished. The drawings were finished as highly as possible, and made of the natural size of the subjects of which they are faithful and beautiful representations. Reductions of these were undertaken by Mr. West for the engravings, which have been executed with so much nicety, that by the use of a reading-glass they possess most of the advantages of larger plates.

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Plate XIX. The sympathetic nerve of the Snake, Boa constrictor.

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